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Plastics

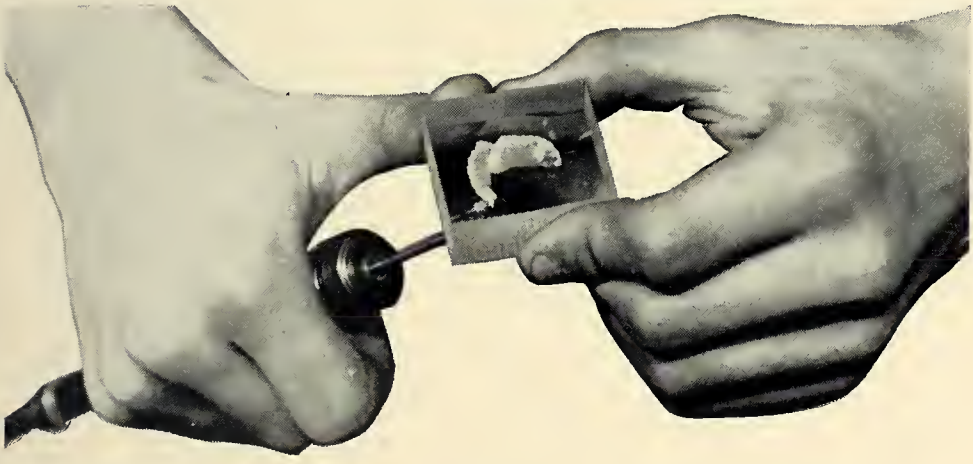
AS AN AREA OF

INDUSTRIAL ARTS INSTRUCTION IN PENNSYLVANIA PUBLIC SCHOOLS

SUBJECT AREAS

Automotive	Home Mechanics	Plastics
Ceramics	Metal Forming	Sheet Metal
Electricity	Metal Machining	Textiles
Graphic Arts	Planning	Woodworking

Internal carving of plastics



BULLETIN 331-I

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC INSTRUCTION • Harrisburg

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Plastics

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Ceramics	Metal Forming	Sheet Metal
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Cementing findings to plastics projects

Bulletin 331-I • 1953

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC INSTRUCTION • Harrisburg

Acknowledgments

Sincere thanks are extended to the following Pennsylvania teachers who have aided materially in the preparation of this bulletin:

R. W. Greaser, *Industrial Arts teacher,* Pottstown Junior High School, Pottstown.

Howard J. Hausman, *Industrial Arts teacher,* Parkland High School, Allentown.

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Stanley F. Schneck, *Industrial Arts teacher,* Coopersburg High School, Southern Lehigh School District, Coopersburg.

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Foreword

THE USE OF PLASTICS, modern chemistry's new product, has grown astonishingly since 1929, and is showing continued development. The industry showed a 600 per cent increase from 1940 to 1950, and the 1950 production totaled 750,000 tons, with a half billion dollar value.[1] No other industry has achieved such tremendous growth.[2]

The possible addition of plastics as an area of activity in a comprehensive general shop should be studied by all school administrators and teachers of Industrial Arts. Contemporary Industrial Arts philosophy advocates the study of and experience with materials, tools, processes, products, and occupations to provide pupils with experiences which broaden their knowledge of our complex industrial society.

This bulletin for administrators, supervisors, and teachers presents the various problems involved in developing, organizing, and teaching the fabrication of plastics as an activity in a comprehensive general Industrial Arts shop. It is supplemental to *Industrial Arts in Pennsylvania,* Bulletin 331, published in 1951 by the Department of Public Instruction. It provides detailed information pertinent to the plastics area.

This bulletin was prepared by Byron Keller, Area Coordinator of Trade and Industrial Education under the supervision of Robert T. Stoner, Chief, Trade and Industrial Education. Preliminary work on manuscript and layout planning were done by R. Randolph Karch, Adviser, Trade and Industrial Education.

This bulletin has been edited by Rachel S. Turner, Editor for the Department of Public Instruction.

Francis B. Haas

JUNE 1953 *Superintendent of Public Instruction*

[1] "A 1950 Guide To The Plastics," Fortune Magazine, May, 1950, p. 109.

[2] Mansperger, M. A. and Carson, W. P., *Plastics Problems and Processes,* Scranton, Pa., International Textbook Company, 1946, p. 9.

Sanding plastics

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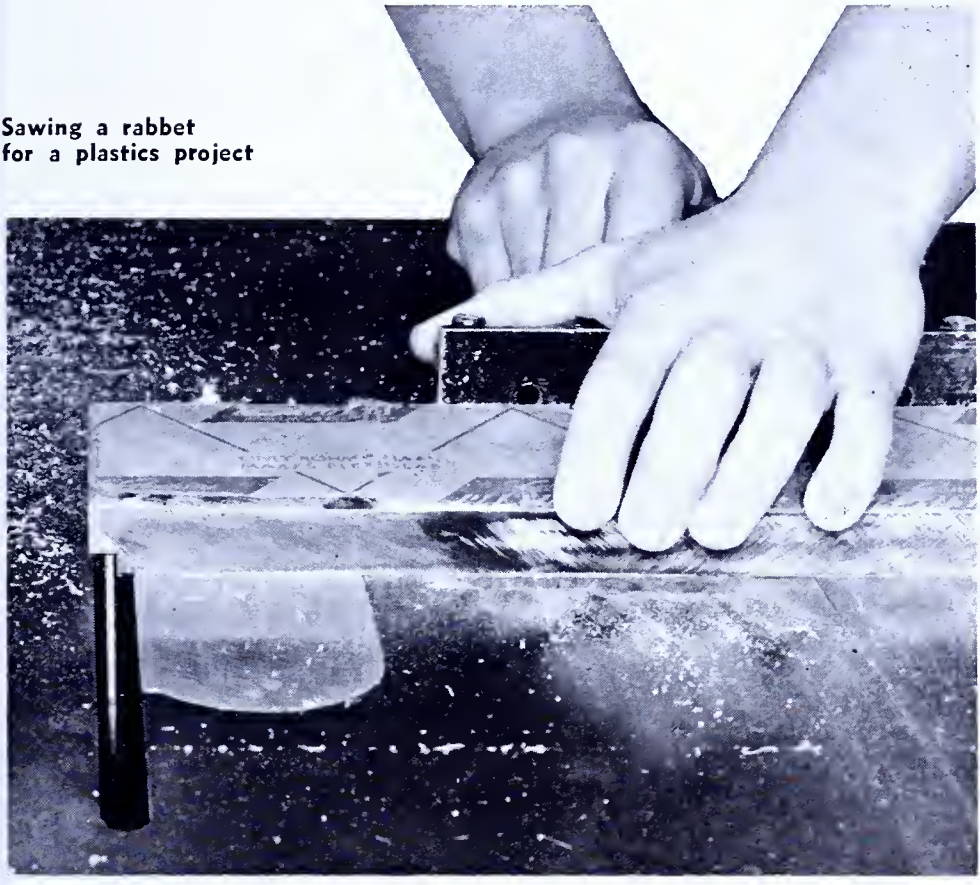

Sawing a rabbet for a plastics project

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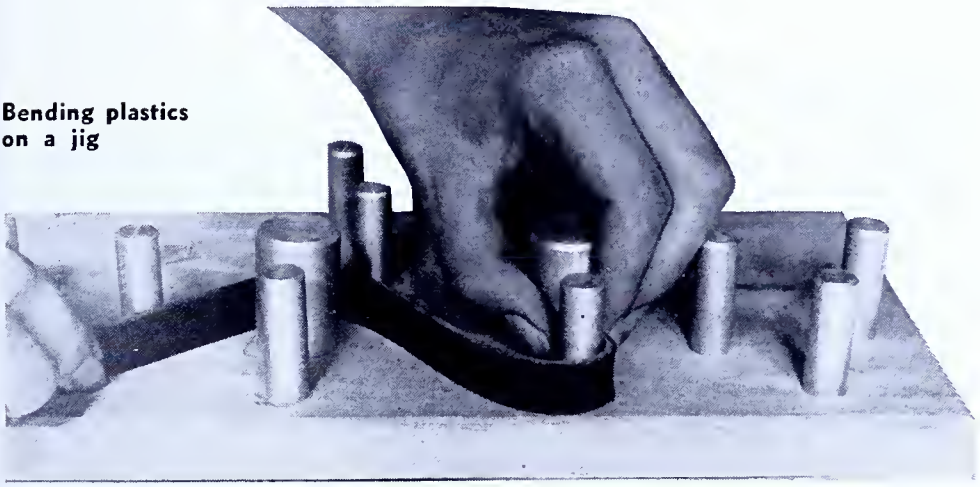
Introduction



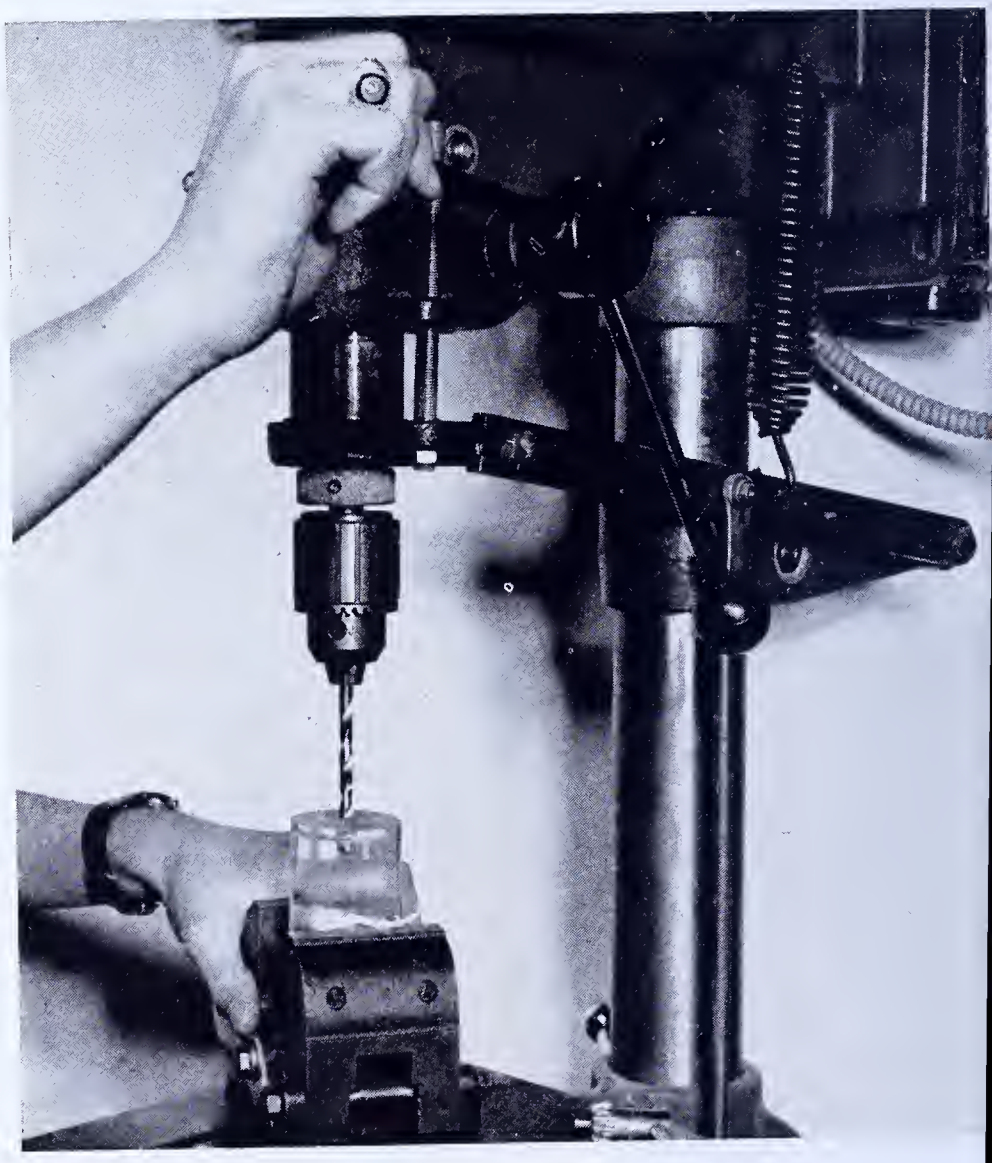
Bending plastics on a jig

BECAUSE of the differences in educational concepts, in backgrounds of the administrator and the teacher, in variations in the time pupils spend in the activity, in amount of funds available for equipment and supplies, as well as in other factors, no attempt is made in this bulletin to set up a common course of study applicable to all situations, or to tell the teacher what to teach, how to teach, or what equipment he should have in his shop.

This bulletin does list, in the "Things to Do" and "Things to Know" sections on pages 7 through 13, course content which may be selected by the teacher. These learning units also help to determine particular aims and objectives, amount of time available to pupils in the Plastics area, and the necessary equipment.

Suggestions to guide the administrator are made on learning units, the organization of instruction, instructional material and devices, possible projects, and the use of records and forms. Included for further guidance are a selected annotated bibliography of readily available instructional materials and visual aids, a suggested inventory of equipment and supplies, their approximate cost, a feasible shop lay-out, and other information related to establishing or enriching the Plastics unit of a comprehensive general shop.

Matters pertaining to Industrial Arts in general are not discussed in this bulletin. For further information the reader is referred to Bulletin 331, *Industrial Arts in Pennsylvania,* published by the Department of Public Instruction, September, 1951.



Drilling plastics

1 Plastics

AS A SCHOOL SUBJECT

Sanding surfaces of a plastics project

Aims and Objectives

THE PUPIL HAS THE OPPORTUNITY to explore and acquaint himself with the fast-growing and important plastics industry. Here is a new world in which pupils can develop worth-while technical skills, creative expression, and consumer intelligence. Through this medium the Industrial Arts teacher can stimulate integration in Art, Science, and Industrial Arts. The fascination of working with plastics, and the low cost of equipment required to develop artistic and worth-while objects, make this activity an excellent hobby medium. It is also an activity in which the instinct of creative design can be developed.

Plastics as a unit in a comprehensive general shop will naturally strengthen any program and help to fulfill the objectives of Industrial Arts as stated in *Industrial Arts in Pennsylvania,* Bulletin 331, published in June, 1951, by the Department of Public Instruction.

The teacher of Industrial Arts should not only be guided by the general objectives as outlined for Industrial Arts education, but he should also determine, specify, and follow specific objectives for each of the units he teaches. Some of the specific objectives of plastics instruction might be stated briefly as follows:

1. To develop the pupils' knowledge of plastic materials

2. To develop the pupils' ability to design, make, and buy pleasing and useful plastic objects
3. To develop the pupils' ability to make, read, and use simple working drawings for the fabrication of projects in plastics
4. To instruct pupils concerning the occupations in the field of plastics
5. To develop an appreciation for the everyday use of plastics in the home and in industry

Materials and Tools

Plastics are synthetic materials. They do not occur in nature, but have been put together (synthesized) by man and therefore are artificial materials. Because they are artificial, some people think they are substitutes—and inferior to wood or metal. The reason for this misconception is the derogatory meaning attached to the word "artificial." But *artificial* in this connotation does not suggest an imitation or something cheap or inferior. The word artificial is derived from the Latin *ars* (art or skill) and *facere* (to make), and in its primary sense is translated as made by art, or skillfully made.

Plastics take so many forms that no one definition can cover all of them. Committee D-20 of the American Society of Testing Materials, which prepares standard texts for plastics, has defined plastics as "any one of a large and varied group of materials, wholly or primarily organic in composition, which may be formed into useful shapes by the application singly or together of heat and pressure." *Organic* means that these materials are made from a combination of carbon with oxygen, hydrogen, nitrogen, and other elements. Plastics come from carbon, which may be coal, in combination with air, water, lime, and vegetable by-products.

Materials for plastics have gone through a series of transformations before they reach the processor who will manufacture plastic objects. The manufacturer has a formula for each plastic resin and combines the chemical he receives for processing by cooking and cooling, wetting and drying, hardening and softening, and by the addition of various ingredients, which include coloring matter. He prepares the plastic materials in the form of molding compounds for the molder; sheets, rods, tubes, extrusions and corrugations for the fabricators; and liquid resins for other processors.

Relatively few plastics have been found suitable for Industrial Arts work. To meet the broad objectives of Industrial Arts the alert teacher will continually look for new kinds of plastics which may be

adopted. The almost phenomenal progress of the plastics industry will continue to improve plastics and develop many new kinds. At present the following plastics, listed by their trade names, have been found satisfactory for shop work:

1. Bakelite (Cellulose Acetate, Phenolics, Polystyrenes, and Ureas)
2. Castolite
3. Catalin
4. Formica
5. Koroseal
6. Lucite
7. Lumarith
8. Micarta
9. Plasticast
10. Plexiglas
11. Saran
12. Tenite
13. Textolite
14. Vinylite

The inclusion of plastics as an activity in a comprehensive general shop does not require the purchase of many expensive tools and machines. Plastics may be worked successfully with the usual woodworking and metalworking equipment. Therefore, the addition of this area of instruction can be achieved with little additional expense in an existing general metal shop or general woodworking shop. The only additional pieces of equipment required are: a heating device, such as an electric oven, hotplate, iron, or infra-red heat lamp; a six-inch buffer; and bending and forming jigs which can be made by the pupils or teacher for the job at hand.

For the more advanced work at the senior high school level, it is necessary to purchase a rotary tool, a flexible shaft machine, and a vibro-tool for such work as carving, engraving, etching, and molding.

Processes

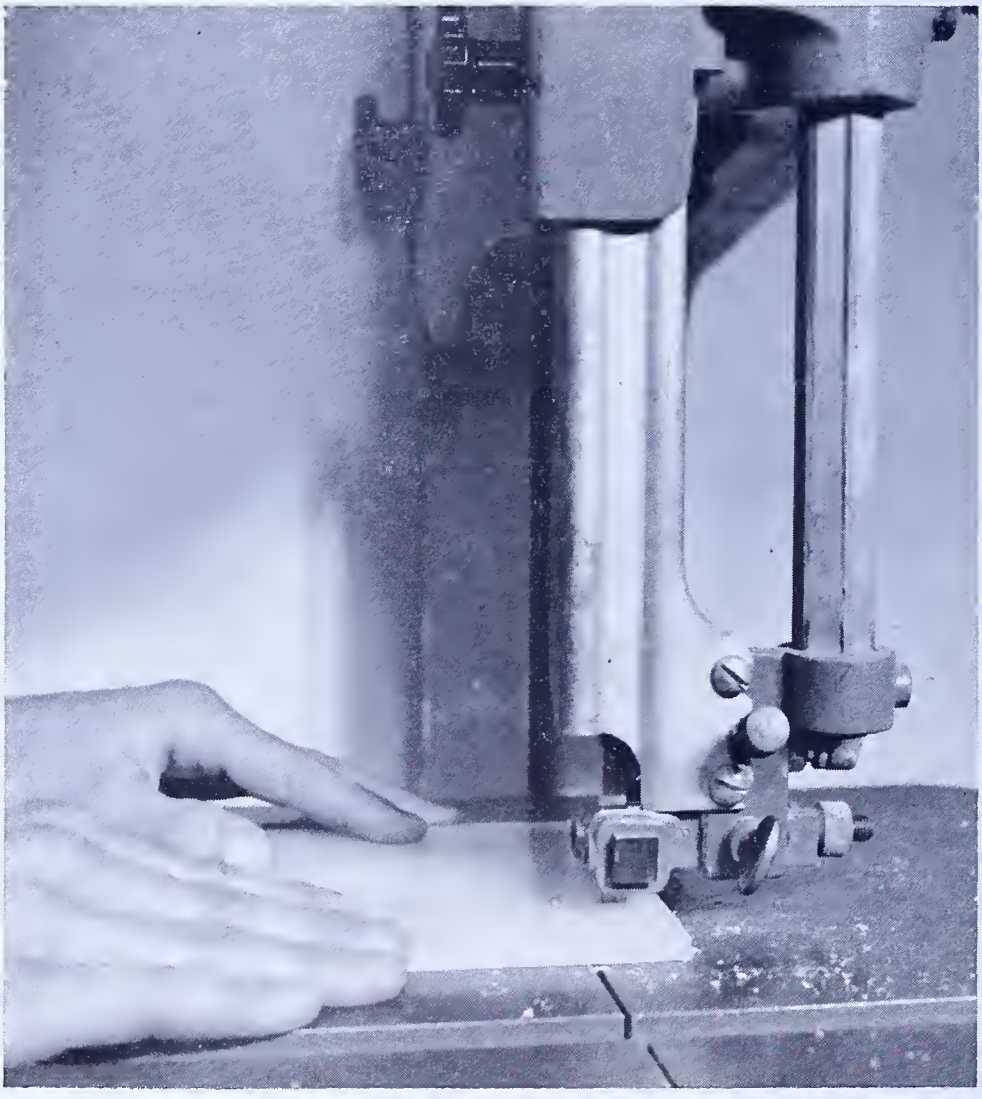
The cast phenolic resins, the acrylics, and the acetates lend themselves well to shop fabrication and are widely used by Industrial Arts teachers. The brilliance and transparency of Plexiglas and Lucite, the two most popular kinds of plastics used in school shops today, make many unusual and beautiful effects possible by faceting, edge-lighting, and light-piping.

The processes involved in fabricating these plastics are: transferring patterns, sawing, dressing edges and surfaces, turning, drilling holes, tapping and threading, forming, fastening, decorating, and designing.

Hand and machine tools used in woodworking and metalworking are suitable for fabricating plastics. However, a peculiar property of plastics causes them to dull cutting edges more quickly than does steel.

Sharp tools are very essential for successful and efficient work. Fine teeth and a negative rake on band and jig saw blades for efficient sawing operation are necessary. Drills should be sharpened as for cutting brass, and woodworking lathe tools must be held higher to reduce the positive rake. (See p. 22) Tool bits should be sharpened with a slightly negative to zero rake for turning in metalworking lathes.

Design is a most important aspect of plastics projects and offers opportunity for the integration of the work in the Industrial Arts department and the Art department. Plastics instruction in the shop inspires pupils to think about original design.



Band-sawing plastics

A knowledge of plastics also provides an excellent medium for hobby development. Because the material is easy to work and few special tools are needed to work it, almost any boy or girl can acquire the necessary equipment for making projects at home.

The casting of plastics in the school shop is now feasible and practicable and should be more widely practiced. One of the most interesting applications of liquid plastics is the embedding of various articles, such as flowers, coins, pictures, photographs, and stamps in bookends, jewelry, and other plastics projects. As a hobby the casting of liquid plastics is limited only by the individual's imagination and ingenuity. The development of this phase should be encouraged.

To meet the broad objectives of Industrial Arts, it is important that the shop teacher incorporate in his plastics course of study as many hand tool operations, machine operations, and other industrial processes as possible. Methods of molding cannot be taught in the school shop because of the complex and expensive equipment required. However, these methods should not be overlooked and should be taught through the use of charts, class discussions, samples, displays, motion pictures, and reference books.

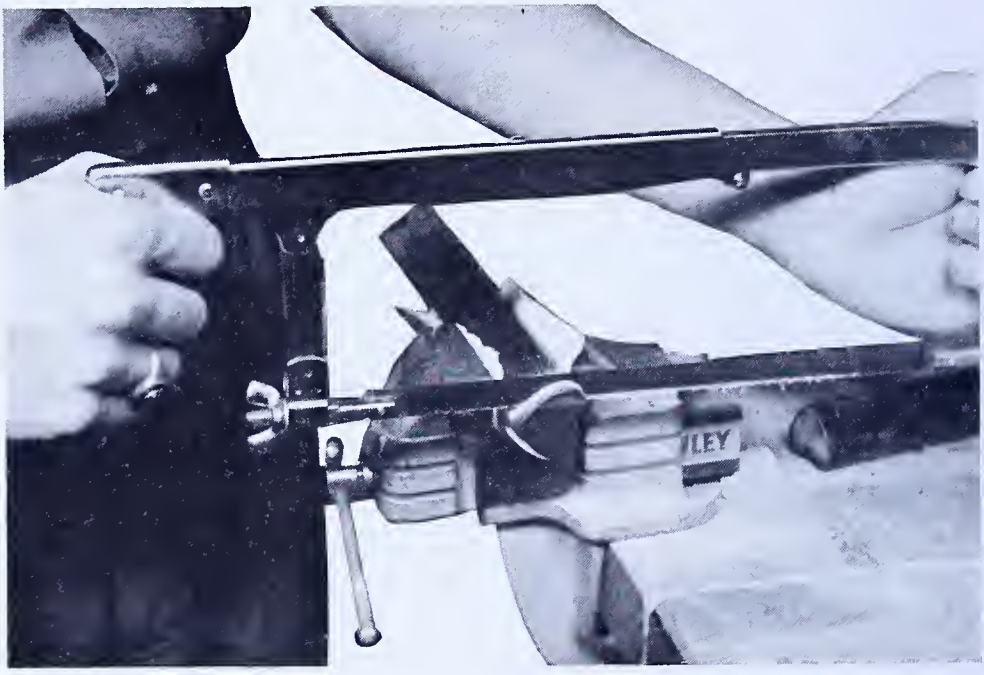
Plastics as an Integral Part of a Comprehensive General Shop

Contemporary Industrial Arts philosophy advocates the use of many different materials, especially at the junior high school level, to provide the pupil with a background of experience which will broaden his knowledge and understanding of the materials with which he comes in contact in his everyday life.

Although plastics is a relatively new industry, it has grown phenomenally and has become important in many of our industries. Therefore, it is important for pupils to become acquainted with the various types of plastics and their uses, to know something about the raw materials which go into their manufacture, and to become acquainted with the methods of fabrication.

Plastics as a General Unit Shop

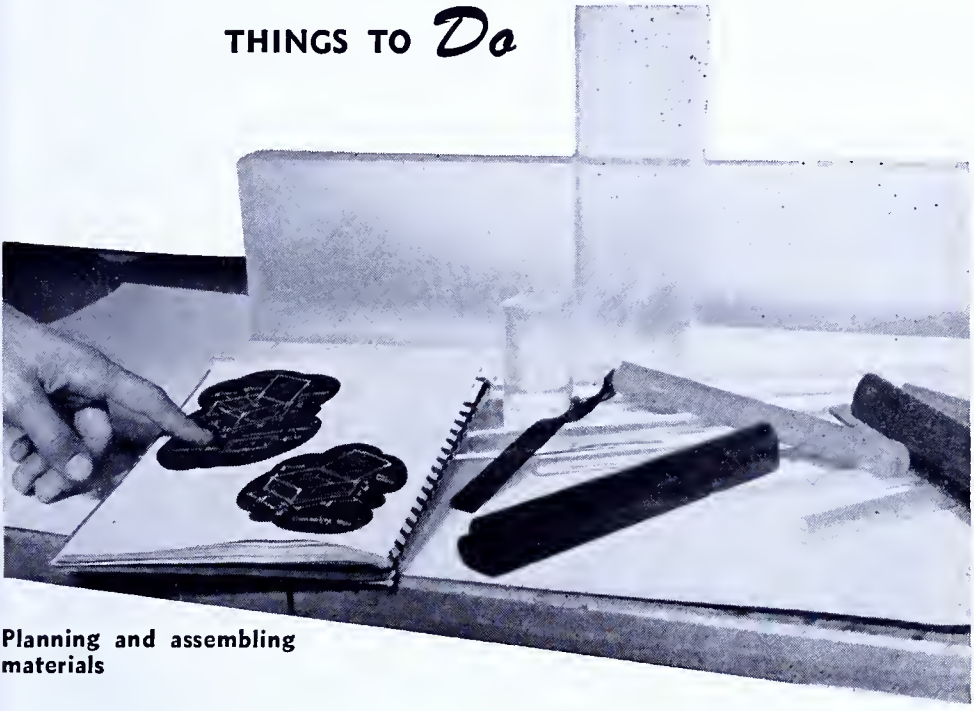
Plastics can be justified on a general unit shop basis (one activity) as well as any of the more common general unit Industrial Arts shops. A general unit shop in plastics is approximately the size of the average metalworking or woodworking shop. Much of the equipment used in a general unit plastics shop would be of the same kind and size as that used in general metalworking or woodworking.



Hack-sawing plastics

2 Learning Units

THINGS TO Do



Planning and assembling materials

HAND AND MACHINE TOOL PROCESSES listed below as "Things to Do" are based upon those performed in the fabrication of plastics. These processes are intended primarily as a guide to the selection of worth-while projects, and to show their similarity to many operations performed in woodworking and metalworking. As new plastics which are suitable for shopwork appear on the market, new processes may be developed.

It should not be assumed that all the processes listed must be included in a course of study. Only those which fit the needs of any particular program should be considered. These processes with their related activities are as follows:

TRANSFER PATTERNS

1. Prepare material
2. Lay out on masked plastics
3. Lay out plastics by attaching paper design
4. Lay out uncovered plastics
5. Cut plastics for economical usage

Cut Out Stock

1. Scribe and break
2. Saw with a coping or jeweler's saw
3. Saw with a hacksaw
4. Saw with a backsaw
5. Cut with scissors
6. Cut with a paper cutter
7. Saw with a jig saw
8. Saw with a wood or metal-cutting band saw
9. Saw with a circular saw

Dress Edges and Surfaces of Plastics

1. File by hand
2. File with a jig saw
3. Scrape with a hand scraper
4. Sand by hand
5. Sand with wet and dry belt sander
6. Sand with band sander
7. Sand with disk sander
8. Sand by drill press
9. Sand with flexible shaft
10. Hand buff
11. Hand polish
12. Ash
13. Buff by power buffer
14. Polish with power polisher
15. Coat with cement

Square Stock

1. Hand file
2. Hand sand
3. Disk and belt sand
4. Saw with circular saw

Make Joints in Plastics

1. Overlap
2. Butt
3. Half-lap
4. Rabbet
5. Miter
6. Reinforced butt
7. Scarf
8. Tongue-and-groove

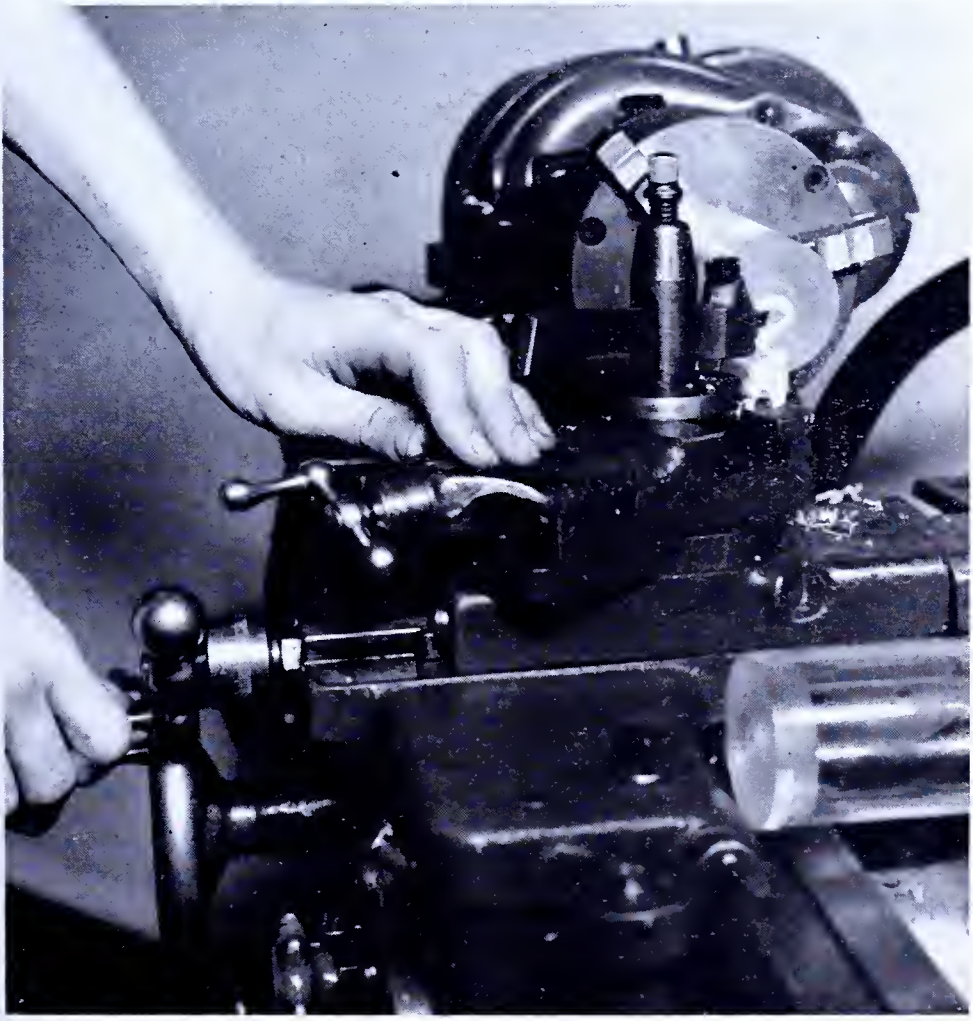
Fasten Plastics

1. Bond with liquid cement
2. Use the soak-method process
3. Use the shrink-fit process

4. Fasten with machine screws
5. Fasten with self-tapping and drive screws
6. Fasten with metal findings
7. Heat and pressure combination

Drill, Bore, Countersink, and Punch Holes

1. Drill with a handsaw
2. Drill with an electric hand drill
3. Drill with drill press
4. Bore on a metal-turning lathe
5. Countersink by hand
6. Countersink by machine
7. Punch holes with a leather punch
8. Punch holes with a straight or pin punch



Turning plastics on a lathe

Tap and Thread Plastics

1. Use a hand tap and die
2. Use a metalworking lathe

Heat Plastics

1. With infra-red lamp
2. By electric oven method
3. With strip heater

Bend and Form Plastics

1. Form freehand
2. Bend around rigid forms, jigs, and fixtures
3. Form by pressure

Use Pressure Devices

1. Hand clamps
2. Vise
3. Weights
4. Wire
5. Linoleum block press
6. Rubber bands
7. Bottle capper
8. Book press
9. "C" clamps
10. Ring and wedge clamps

Decorate Surfaces and Carve Internally

1. Carve with hand tools
2. Carve with a flexible shaft machine
3. Engrave with a vibro-tool
4. Engrave with a pantograph engraver
5. Engrave with an electric pencil
6. Emboss
7. Etch
8. Paint designs with lacquers and oil paints
9. Inlay
10. Overlay
11. Apply silk screen process
12. Apply decalcomania process
13. Apply gold leaf

Color and Dye

1. Use cold-dip dye
2. Use hot-dip dye
3. Use hypodermic needle
4. Use paint brush
5. Use laminating dyes

Cast Plastics

3 Learning Units

THINGS TO Know

Cementing plastics with colored laminating cement

RELATED INFORMATION listed below pertains to plastic materials, and includes the fabrication of plastics products, employment opportunities, history of plastics, and consumer appreciations.

Information should be divided into units, and the best teaching method selected for each unit. Chart 1, page 12, should be of help in selecting the best teaching method.

Chart 1 may also be used in keeping a convenient record of what has been taught in each class and what remains to be taught. It is, in a broad sense, a course of study for related information presented in chart form. The method of teaching a given unit as illustrated by this chart is only suggested and is not intended to be the only acceptable method.

The following listing suggests what should be known about plastic materials and how such knowledge may be put to practical use:

Grade or Section

PLASTICS AREA–RELATED INFORMATION

METHODS AND DEVICES	Demonstration: Teacher	Demonstration: Pupil	Shop Talks: Teacher	Shop Talks: Outside Authority	Visual Aids: Motion Pictures	Visual Aids: Strip Films	Visual Aids: Display Boards	Visual Aids: Charts	Visual Aids: Mock-Ups	Visual Aids: Models	Visual Aids: Opaque Projection	Instruction Sheets: Operation Sheets	Instruction Sheets: Job Sheets	Instruction Sheets: Information Sheets	Instruction Sheets: Assignment Sheets	Class Discussions: Pupils and Teacher	Reports: Pupil	Problems: Classroom	Problems: Home	Published Materials: Bulletins	Published Materials: Pamphlets	Field Trip	Pupil's Notebook	Library Assignments	Mottoes
Shop Organization																									
Care of Tools and Equipment																									
Planning a Project																									
Safety with Hand Tools																									
Safety with Machine Tools																									
Working Drawings																									
History and Development																									
Characteristics of Plastics																									
Trade Names of Plastics																									
Commercial Processing Methods																									
Commercial Uses																									
Kinds of Cements																									
Kinds of Dyes																									
Mixing Dyes																									
Jewelry Findings																									
Tool Sharpening																									
Buffing Wheels, Speeds																									
Abrasives and Compounds																									
Fasteners																									
Employment Opportunities																									
Plastics and the Future																									

CHART 1

Plastic Materials

1. Brief history and development
2. Definition of plastics
3. Terminology
4. Classification
5. Characteristics of common plastics in use
6. Trade names, and adaptability to craftwork
7. Acrylic plastics
8. Cast phenolic resin plastics
9. Cellulose acetate plastics
10. Cellulose nitrate plastics
11. Vinyl resin plastics

12. Styrene plastics
13. Urea plastics
14. Polyethylene resins
15. Polyamide resins
16. Casein plastics
17. Laminated plastics
18. Resin-bonded plywood
19. Ethyl cellulose

Commercial Processing of Plastics

1. Compression molding
2. Injection molding
3. Transfer molding
4. Extrusion molding
5. Casting
6. Laminating
7. Preforming
8. Wrapping
9. Rolling

Commercial Uses of Plastics

1. Clothing and personal accessories
2. Aircraft industry
3. Automobile industry
4. Communications
5. Household furnishings and building supplies
6. Sign industry
7. Industrial applications

Kinds of Cements and Their Uses

Kinds of Dyes and Their Uses

Jewelry Findings Used With Plastics

Tool-sharpening

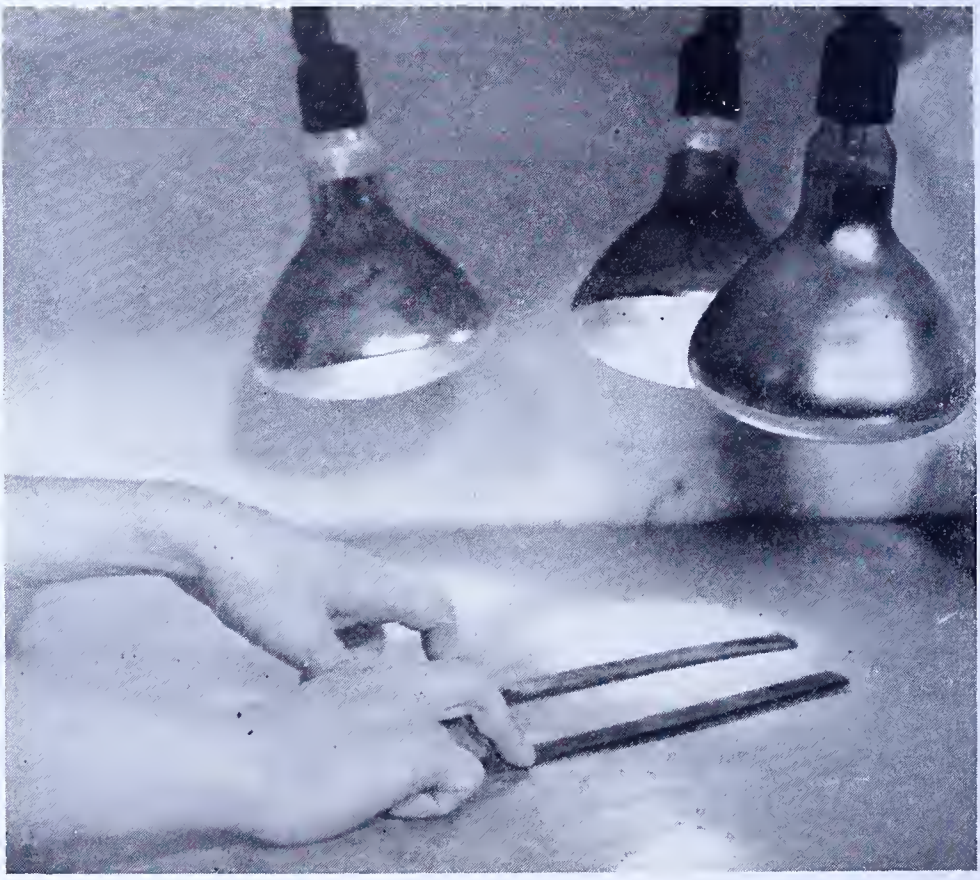
Buffing Wheels, Their Speeds and Compounds

Care and Storage of Plastics

Safety Precautions for Handling Plastics

Employment Opportunities

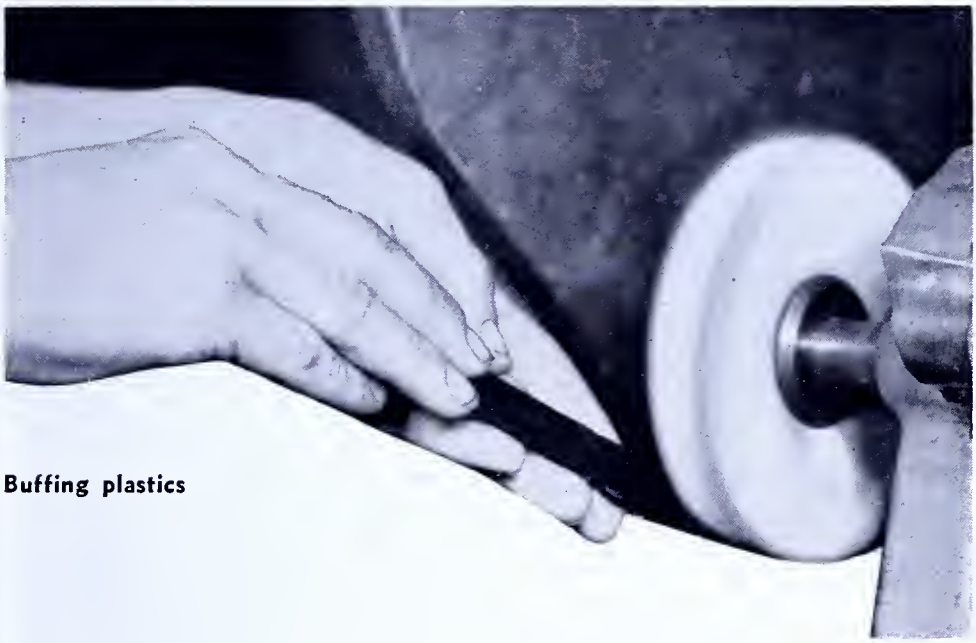
Plastics and the Future



Heating plastics prior to forming

4 Organization of Instruction

INSTRUCTIONAL MATERIAL AND DEVICES



Buffing plastics

THE ALERT AND PROGRESSIVE TEACHER will study the special advantages of every type of instructional aid available. He will make full use of these instructional aids in his search for better ways to motivate interest and increase pupil understanding. He will make the most of such devices as blackboards, charts, diagrams, maps, photographs, filmstrips, film slides, movies, opaque projectors, models, specimens, and mock-ups.

The comprehensive general shop concept of Industrial Arts has developed new methods of teaching. Teacher direction has given way to pupil self-direction and learning under teacher guidance. This concept of shop instruction requires a new type of learning and teaching environment. In order to meet individual pupil interests, work in a comprehensive general shop may involve as many different jobs as there are pupils. Some pupils may make identical projects or a project that has been made successfully before. Because of the opportunities for differentiation, other students will construct projects which cover a wide range of interests during the school year. It is

PLASTICS AREA ANALYSIS FORM

GRADE LEVEL LEGEND: R–Required; O–Optional; √–Inadvisable

Grade Levels	7	R	O	O	√							
	8	O	O	R	√	√						
	9	O	O	O	O	O						
BASIC PROCESSES		Shade Pull	Brooch	Letter Opener	Picture Frame	Jewel Box						
1. Read a working drawing		x	x	x	x	x						
2. Make a plan of procedure		x	x	x	x	x						
3. Lay out stock		x	x	x	x	x						
4. Get out stock by hand		x	x	x								
5. Get out stock by machine					x	x						
6. Smooth edges by filing		x	x	x								
7. Smooth by sanding machines					x	x						
8. Smooth with a plane				x								
9. Smooth with a jointer												
10. Smooth with sandpaper		x	x	x	x	x						
11. Polish on buffer		x	x	x	x	x						
12. Polish by hand		x	x									
13. Dritt holes by hand		x	x	x								
14. Drill holes by machine					x	x						
15. Tap threads					x	x						
16. Cut external threads												
17. Countersink a hole						x						
18. Prepare surface for cement			x	x	x	x						
19. Prepare cement			x	x	x	x						
20. Join with cement			x	x	x	x						
21. Join with machine screws					x	x						
22. Join with drive screws			x									
23. Carve by hand					x	x						
24. Carve using machines					x	x						
25. Engrave by hand					x							
26. Engrave using machines					x							
27. Decorate with overlay				x								
28. Decorate with inlay												
29. Decorate with dye												
30. Decorate with enamel												
31. Turn on wood lathe												
32. Turn on metal lathe												
33. Form by hand												
34. Form using jigs, clamps, etc.												
35. Attach findings												
36. Fasten by soak-method process												
37. Do ashing												
38. Vacuum snapback forming												
39. Casting												
40. Injection molding												

CHART 2

necessary, therefore, to plan for methods of pupil self-direction and pupil planning, and to organize instructional material, devices, records and equipment so that the teacher will be relieved of detailed work.

The Course of Study

A good course of study should be used in every area of the comprehensive general shop. Courses of study may differ in their content and appearance, and need not correspond to any pattern. In a broad sense, the term course of study can be applied to any organized set of outlines or plans which guide the teacher and pupils through a definite program of instruction and learning.

The teacher must first acquaint himself with the factors which will influence his particular teaching situation in the preparation of a course for study for the plastics area. For example:

1. Age range of pupils
2. Grade levels
3. Length of periods
4. Number of periods per week and per year
5. Previous experience of pupils
6. Tools, equipment, materials, and other facilities available
7. Special considerations pertinent to the school

A thorough study of these factors will answer many questions for the teacher and allow him to plan an effective teaching program.

The course of study is the teacher's road map. Without a plan and suitable records, Industrial Arts pupils drift through the year learning very little, and in some instances, miss the important values of shop work.

How to Select Significant Projects

Projects chosen as the basis for a course of study should be carefully selected. The pupil should learn to master many operations and skills in the construction of these projects and will also learn how to use different kinds of plastic materials. The teacher should permit variations of design and the substitution of projects where such changes do not upset the smooth operation of the class. A project analysis device, illustrated in Chart 2, page 16, will help the teacher determine the most desirable grade level of any given project. The analyses of the several projects listed are merely illustrative, and are not intended to illustrate the type of project best suited to any given grade level. The grade level of a plastics unit in a comprehensive general shop will be determined by other offerings and conditions pertinent to the total education program.

Beginning projects should consist of a small number of basic learning units selected by the teacher and required of all students as standard projects. This procedure will get the class under way without delay and confusion. Subsequent projects should involve new learning units and should provide practice in the old. As pupils advance in knowledge and skills, they should be permitted and encouraged to select their own projects with the advice of the teacher. Pupils should choose from a group of approved projects, leaving free choice until such time as the pupil has mastered fundamental tool processes and acquired sufficient experience to make wise selections. Final approval of the selection should rest with the teacher.

Regardless of who makes the project selection, projects should conform to the following standards:

1. Contain some of the learning units desired
2. Be simple enough to come within range of the pupil's ability, yet difficult enough to challenge his resourcefulness
3. Be of such nature as can be handled under school shop conditions
4. Embody good design and have some intrinsic value to the home or community
5. Be of such nature that they can be completed within a reasonable or specified time
6. Have sufficient value in the pupil's estimation to nurture further interest

Suggested Projects and Grade Levels

Because of the many variable factors involved in school organizations, the list in Chart 2, page 16, should be considered only as a guide in selecting suitable projects for any grade level. It should not be assumed that a pupil should work only on elementary projects if he is capable of doing more advanced work. Individual pupil differences, other areas of instruction, previous shop experience, and number of periods of shopwork are among the factors to be considered in assigning projects.

The basic processes of plastics fabrication can be successfully performed by most seventh, eighth, and ninth grade pupils. However, the most intricate processes, such as carving, engraving, dyeing, casting, and injection molding are more successfully performed by senior high school pupils. The senior high school presents many opportunities through the medium of plastics to develop the creative and artistic talents of pupils.

Instruction Sheets

Well-written and well-illustrated instruction sheets are of assistance in the operation of a comprehensive general shop. Their use gives the shop teacher more time for individual instruction and other important duties. Instruction sheets save pupils' time by reducing their dependency on the teacher, and develop confidence and self-reliance in pupils by giving them valuable experience in working from printed directions.

The sample instruction sheets on pages 20 to 25 are suggested forms and are not meant to establish any uniform style.

Four types of instruction sheets have proved useful in school shops. Each type is designed for a specific purpose as an aid to teaching and is not intended to take the place of the teacher. These instruction sheets are:

1. *The Sample Pupil Project Assignment* which gives directions on how to do a project involving the application of a number of operations or units of instruction. See page 20.
2. *The Sample Operation Sheet* which gives directions for performing a basic manipulative operation. It is based on learning principles rather than the performance of an actual job. See page 22.
3. *The Sample Information Sheet* which covers a unit of related technical or occupational information. See page 23.
4. *The Sample Pupil Project Plan* which serves a variety of purposes. It may be designed to direct reading and observation, or to provide a form on which the pupil may plan, sketch, and evaluate his work. See page 24.

Laying out a plastics project

SAMPLE PUPIL PROJECT ASSIGNMENT

HOW TO MAKE A LAMINATED HEART

Objective: This small inexpensive project is an excellent piece of costume jewelry which will make a beautiful and useful gift for your mother, sister, or friend. Through its construction you will learn such basic processes in the fabrication of plastics as getting out stock; tracing a design; filing, sanding, polishing, and cementing; drilling a hole; and attaching a screw-eye.

Material Required for a Medium-Sized Heart:

2 pieces of plexiglas, ¾″ x ¾″ x 1½″
10 drops colored laminating cement
1 small screw-eye
1 18″ piece of ribbon or sterling silver chain
1 jump ring

Tools Required:

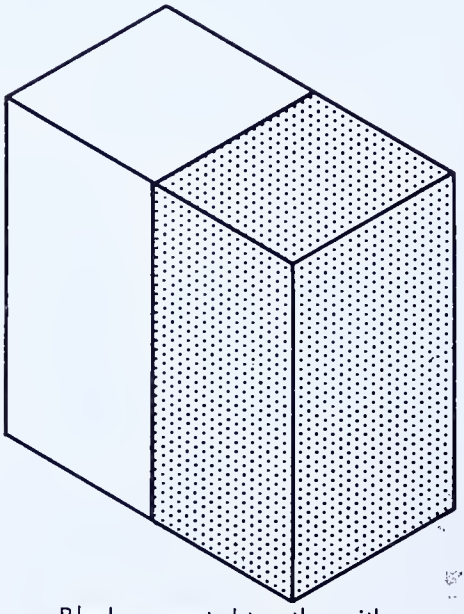
Hand

File—flat, 8″, 2d cut, double cut
Coping saw
Sandpaper—½ grit, 2/0 grit, 4/0 grit

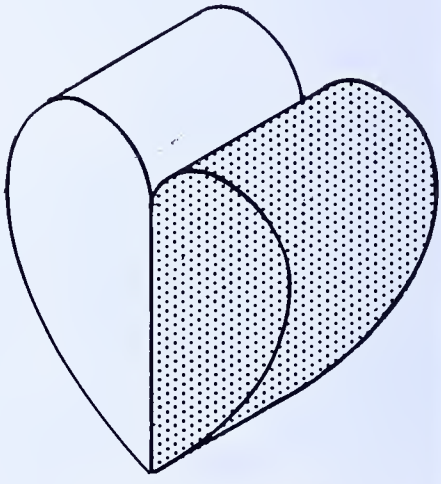
Cloth and polishing compound
Small hand drill or pin vise

Machine

Sander (disc or belt)
Band saw
Buffer



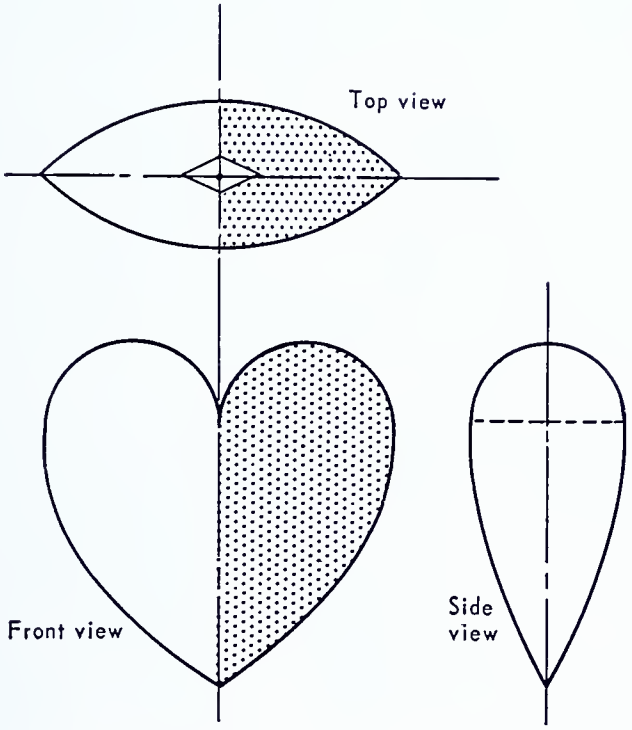
Blanks cemented together with colored laminating cement



Blanks after rough cut

Procedure:

1. Cut out plexiglas blanks
2. Cement blanks together
3. Dry for 24 hours
4. Draw design on blanks
5. Cut out
6. File and sand to please the eye
7. Buff and polish
8. Drill hole
9. Install screw-eye
10. Attach chain or ribbon



Blanks after shaping to please the eye

SAMPLE OPERATION SHEET

HOW TO DRILL HOLES

An ordinary twist drill may be used to drill plastics. A hand drill will do satisfactory work if properly operated. If a power drill is used, the feed must be slow to prevent the plastics from chipping on the under side.

Ordinary drills ground with a positive rake may be used. Better results are obtained, however, if the drills are ground with a slight negative rake. Fig. 1, below, shows a drill bit properly ground for drilling plastics.

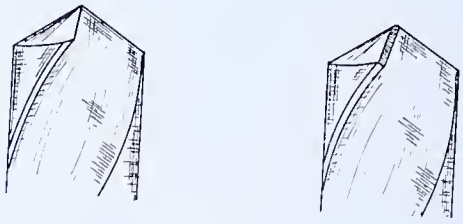


Fig. 1

Procedure for Hand Drilling

1. Center-punch for the hole location
2. Use a twist drill which has been ground for drilling plastics (Fig. 2)

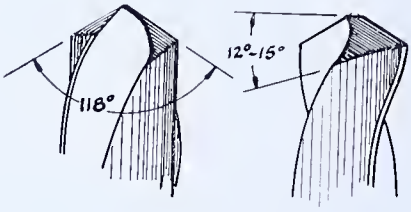


Fig. 2

3. Fasten the work in a bench vise or place it on a piece of scrap wood on the bench top and hold in position with a hand screw or "C" clamp
4. Remove the drill frequently to clean out the cuttings

Procedure for Drilling with a Drill Press

1. Center-punch for the hole location
2. Use a twist drill which has been ground for drilling plastics (Fig. 2)
3. Fasten work in a drill press vise or a jig made for the specific job
4. Run the drill at a moderate speed of about 120 feet per minute
5. Lubricate the drill with a mild soap solution for best results

SAMPLE INFORMATION SHEET

COMMON JOINTS USED IN PLASTICS FABRICATION

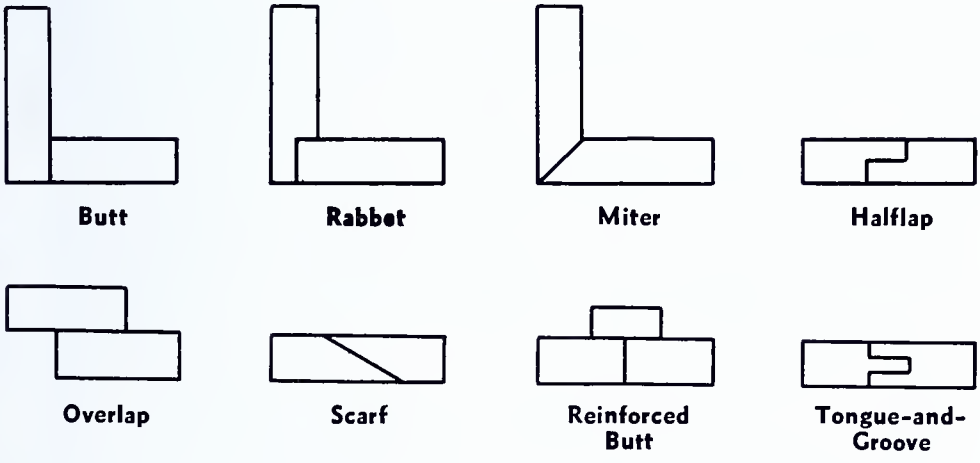
Objective: To give information on the common types of joints to be considered in designing plastics projects.

Nearly all conventional joints used in woodworking can be duplicated in plastics. The selection of a joint should be based on the general design of the project and the service required of it. Irregular and curved pieces should be heated and formed, and held by specially designed clamping fixtures to produce good contact for cementing.

Machined surfaces are superior to polished surfaces for cementing because polished surfaces have a tendency to "craze" when cemented. Also, greater clarity can be achieved with unpolished cemented surfaces.

Great care must be exercised in making joints. Trial fits, without cement, should be made for testing squareness, location, and size before joints are assembled permanently.

COMMON JOINTS



Questions:

1. Why is it essential to give considerable thought to the proper types of joints to be used in the construction of a project?
2. Are these joints the only ones which should be used?
3. Can joints be made without cementing the pieces together? If so, what other devices are used to hold pieces of plastic together?

SAMPLE PUPIL PROJECT PLAN

..... High School

..... School District

Name..... Grade..... Section.....

Project..... Teacher Approval..... Date.....

Sketch: Make a working sketch below of the project to be made.

Procedure: List the principal steps in doing the project showing what you will do first, second, third, etc.

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....
7. .....
8. .....
9. .....

(REVERSE OF PUPIL PROJECT PLAN)

Bill of Material

Quantity	Description of Stock (Name, shape, size, color)	Unit Price	Cost

Helpful Hints in Estimating Cost of Materials[1]

Broad Measure Formula:

$$\frac{\text{No. pcs. x thickness in inches x width in inches x length in feet}}{12} = \text{Board fe}$$

$$\frac{\text{No. pcs. x thickness in inches x width in inches x length in inches}}{12 \quad x \quad 12} = \text{Board fe}$$

Sheet plastics, cork, plywood, and sheet metals are sold by the square foot

Dowel rod, square stock for turning, wrought iron, bar stock, plastic rods and tubes are sold by the linear foot

Casting metals, clays, glazes, and yarn are sold by weight

Evaluation

What tools have you used that were new to you?

List the improvements you would make in repeating this project.

Teacher's Comments:

[1] Prices of materials are on the bulletin board.

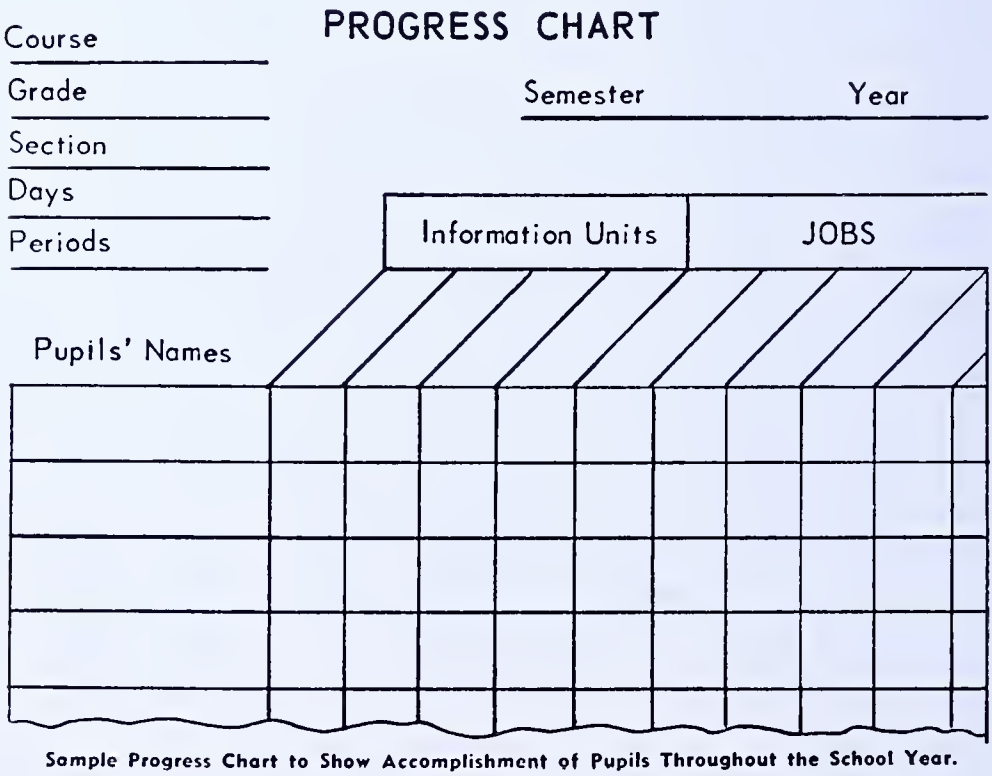
Use of Records

Without a plan for the year's work and without suitable records, Industrial Arts pupils may drift through the year accomplishing very little, and, in all probability, will miss many values of shop experience. Teachers can develop more effective shop programs through records which **show:**

1. Projects completed by the pupil
2. Related lessons taught by the teacher
3. Demonstrations performed by the teacher
4. Operations and processes performed by the pupil

In the development of a pupil personnel management system, the responsibility of keeping some records can be delegated to pupils. Records may also be kept by individual pupils as cumulative project record cards. Regardless of the system developed, the efficient general shop teacher has a record of what he has taught, what remains to be taught, and the progress of each pupil and class.

The sample progress and cumulative project record charts on pages 26 and 27 were developed to facilitate record keeping for the general shop teacher.

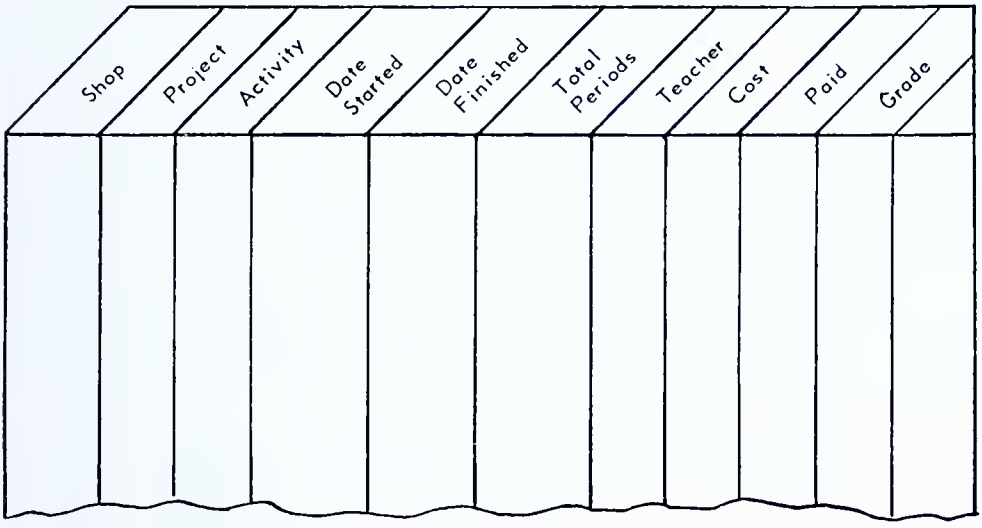


Sample Progress Chart to Show Accomplishment of Pupils Throughout the School Year.

Name Grade 7 8 9 10 11 12 PG

PUPIL CUMULATIVE PROJECT RECORD

Industrial Arts Department School City



Sample of a Cumulative Project Record Form to be Kept Throughout a Pupil's School Experience

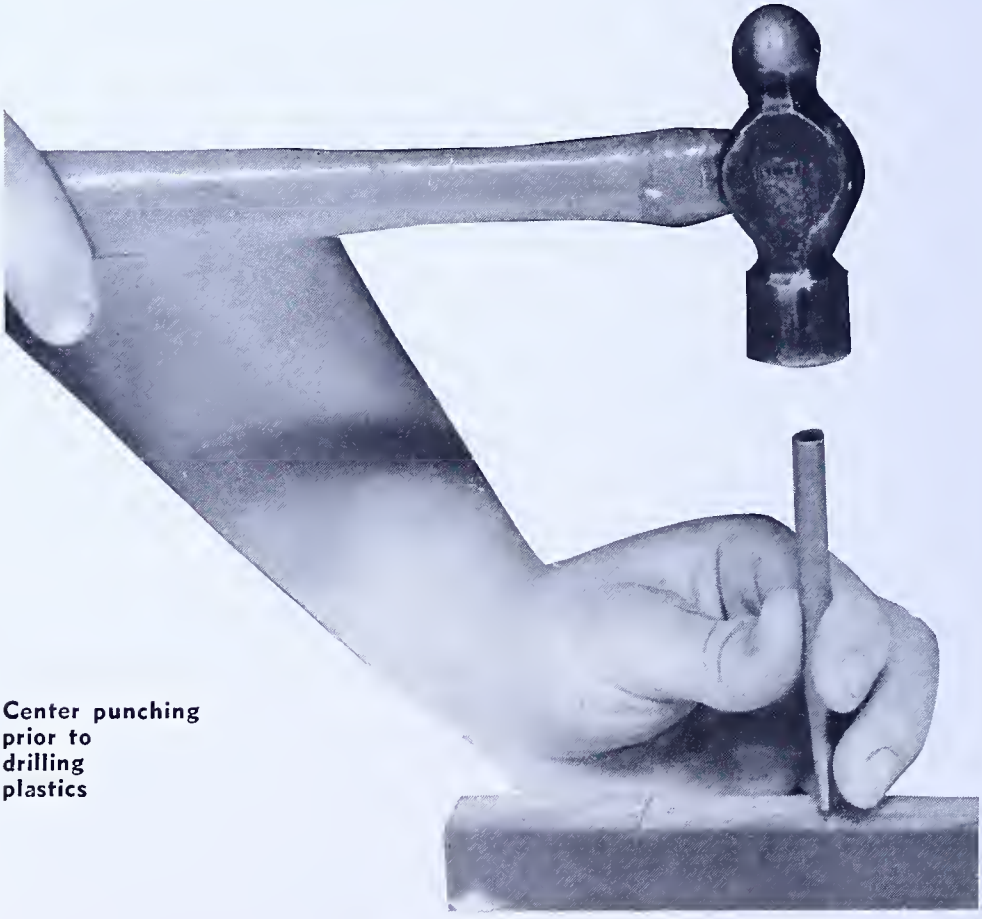
Shop Management Organization

As the activities presented in Industrial Arts shops are increased in number and scope, it is expedient for the teacher to assign some of the routine duties to pupils. The purpose and the plan itself will not be the same for all schools, depending on the activities offered, size of class, age of students, length of periods, and physical layout of the shop. This cooperative plan is an effective device for achieving the following common Industrial Arts objectives:

1. To present practice in leadership and "followership"
2. To motivate the pupils' understanding of industrial operations and applications
3. To develop responsibility and a feeling of belonging to the activity
4. To aid the teacher in many routine duties

The shop management activities should be planned and organized by the class. A teacher-imposed plan is readily recognized by the pupils, and has a tendency to destroy pupil interest. Better cooperation can be developed, therefore, through a personnel plan developed by the pupils with teacher guidance and direction. Pupils may assist in the development of the plan as a class or through a committee of pupils from several classes. A plan developed in this manner motivates the pupils' interest in industrial personnel organization and provides an incentive for the study of local plant personnel systems. The extra time spent in the democratic development of this plan is more than compensated by the added cooperation attained by the teacher, and the guidance value received by the pupils.

In order to make a pupil shop management plan operate successfully, the importance, need, and practicability must be explained carefully to the pupils. The success of the program depends entirely upon the pupils' acceptance; therefore, the teacher should plan his presentation carefully in order to justify the value and need of such a program.



Center punching prior to drilling plastics

A PARTIAL CHECK LIST ON CARE OF THE PLASTICS AREA

This check list may serve as a guide to the teacher in keeping the Plastics Area functioning in good order.

	Yes	*No*
1. Establish a periodic check list for lubrication of all equipment	____	____
2. Provide for adequate tool storage	____	____
3. Have a place for every tool	____	____
4. Provide suitable storage for plastic materials to prevent warping	____	____
5. Provide for storage of scrap plastics	____	____
6. Keep all cutting tools for plastics on a special tool panel to prevent their being used on other materials	____	____
7. See that all buffers are properly protected with safety shields, belt guards, and dust collectors	____	____
8. Provide adequate and accessible storage for buffing supplies	____	____
9. Provide adequate storage for incompleted projects	____	____
10. Schedule a regular time for cleaning all machinery used in this area in order to remove fire hazards caused by plastic dust	____	____
11. Provide adequate storage for jewelry findings	____	____
12. Provide adequate fire extinguishers	____	____
13.	____	____
14.	____	____

5 Instructional Aids

BOOKS, MAGAZINES, FILMS

Cementing plastics

In a bulletin of this size it is not possible to list all available materials in the form of books, pamphlets, study guides, charts, and catalogs. However, an attempt has been made to list some reference materials with publisher, date, number of pages, author, and annotation of the contents so that the Industrial Arts teacher will know what they contain.

BOOKS

Adams, J. V., *Plastic Arts Crafts.* New York, N. Y., D. Van Nostrand Co., 1948, 147 pp., $2.20

Here is a text from which one can quite literally "learn to do by doing." The pupil can start with any one of four basic projects at the beginning of this book and learn tools and processes as he turns out plastic pieces. Basic projects are followed by more complicated ones.

Cherry, Raymond, *General Plastics Projects and Procedures.* Bloomington, Ill., McKnight and McKnight, 1947, 160 pp., $1.50

This book tells how to fabricate all common types of plastics by hand and machine tools; includes instruction on internal carving; and features over 300 illustrations and 49 completely worked-out projects.

DeWick, E. S., and Cooper, J. H., *Plastic Craft.* New York, The Macmillan Company, 1946, 184 pp., $5.00

An integration of training in industrial arts, fine arts, and home crafts. Besides providing interesting, original work for any home or school shop and for any degree of skilled work that can be done with only elementary tools, it also provides projects for woodworking, metalworking, and machine tools. Many projects for those with artistic skill are included. All the practical, working processes for plastics in the school or home are fully explained, including such new processes as heat-sealing and dip-dyeing. All the necessary information about materials is given (including how they may be treated and where they may be obtained). Every step in the use of tools and in the construction of plastic objects is clearly illustrated.

Dubois, H. K., *Plastics.* Chicago, Ill., American Technical Society, 1946, 447 pp., $5.00

A practical book for actual users of plastics who need basic information on materials, and also for those interested in going into the field of plastics or using them in connection with their products.

Dubois, J. H. and Pribble, W. I., *Plastics-Mold Engineering.* Chicago, Ill., American Technical Society, 494 pp., $7.00

The fundamentals of plastics-mold design and construction are presented in a practical, clear, and interesting manner.

Dunham, Arthur, *Working With Plastics.* New York, N. Y., McGraw-Hill Book Co., 1945, 230 pp., $3.50

The relatively new field of plastics is presented in the light of current educational pedagogy, using the trade-analysis method. Projects are arranged in logical sequence from the simple to the more complex. The book includes general information; fundamental operations in phenolic and acrylic plastics with projects in both; safety in the use of tools and equipment; design and color; and vocational information. A helpful glossary is included.

Groneman, Chris H., *Plastics Made Practical.* Milwaukee, Wis., Bruce Publishing Co., 1948, 315 pp., $4.50

Ninety-seven illustrated projects which can be made from the more commonly known plastics, 10 special designs, 300 illustrations consisting of working drawings of each project, and the operations involved in the various processes. An ideal book for the Industrial Arts shop and laboratory. Also contains such general information on plastics as a list of manufacturers of supplies and equipment.

Lockrey, A. J., *Plastics in the School and Home Workshop.* New York, N. Y., D. Van Nostrand and Co., Inc., 1948, 239 pp., $3.00

This book emphasizes the use of the less expensive plastics and the simple hand tools found in the average shop. Some projects require machine tools standard to most shops. The text gives a solid course in plastic-working translated in terms of specific projects. The new third edition has added forty projects using the various acrylics.

Mansperger, Dale E., and Pepper, Carson W., *Plastics Problems and Processes.* Scranton, Pa., International Textbook Co., 352 pp., $3.00

An introduction to plastics without placing too much technical stress upon any particular phase of the subject. Projects are related directly to the pupil's social environment. This book contains 65 problem plates, 215 designs, and 166 figures.

Newkirk, L. V., Coleman, Hewitt, and Zutter, LaVada, *Adventures With Plastics.* Boston, Mass., D. C. Heath & Co., 1947, 275 pp., $3.95

Contains such recent information as making clear joints without cements, by friction and welding. Among the projects which can be made for a few dollars are: effective ovens from garbage pails and infra-red bulbs; an effective strip heater from pyrex tube and nichrome wire taken from an old electric heater; how to

make your own setup for doing vacuum forming of small domes, and how to preserve specimens and other objects in crystal-clear blocks of lucite or plexiglas.

Richards, Benjamin T., *Handcraft in Plastics,* Peoria, Ill., Charles A. Bennett Co., 1949, 92 pp., $1.75

This book meets the needs of everyone who wants to work in plastics through its presentation of: the various plastics, their properties, and how to work them; necessary materials and tools; step-by-step processes and methods of construction. Many useful projects are included.

Rohm and Haas Co., *Plexiglas Design and Fabrication Manual.* Philadelphia, Pa., 60 pp., $.60

This book tells how to properly saw, drill, and machine plexiglas and lucite. Fifteen pages are devoted to a discussion of the proper methods of forming and cementing acrylics. Such important subjects as edge lighting, light control, piping around curves and corners, prismatic and lens effects, and good design in routing, cementing, fastening, threading and riveting are discussed in detail. Vacuum snapback forming of three dimensional parts, and how to design for maximum brilliance are also explained. This is not a project book. It does not give plans or details on how to make plastic articles, but does give the technical "know-how" on how to use these plastics in any application.

Rohm and Haas Co., *Working With Plexiglas.* Philadelphia, Pa., 1947, 72 pp., $1.50

This book shows methods and techniques for fabricating plexiglas, and recommends hand and power tools required. The designing and the decorating of plexiglas are treated in a simple, easy-to-understand manner. Thirty useful projects are included as well as specifications for plexiglas sheets and rods, materials, supplies, and equipment for fabricating this plastic. It has over three pages of copy and illustrations on how to do internal carving.

Walton, Henry, *Plastics for the Home Craftsman.* New York, N. Y., McGraw-Hill Book Co., Inc., 190 pp., 223 illustrations, $4.00

This is a simple, easy-to-follow book that gives detailed instructions for making a great variety of decorative and useful things out of plastics for the home. All the fundamental operations are plainly described; plans, methods, and finished objects are illustrated in over 200 drawings and photographs.

Zoback, Harry, *Internal Carving in Plastics.* New York 11, N. Y., Horton Publishing Co., 40 pp., $1.50

This book is devoted exclusively to the new and fascinating art of internal carving in plastics. It is profusely illustrated with diagrammed instructions explaining in detail methods of doing this work in plexiglas and lucite. Fourteen different projects are explained step by step.

MAGAZINES

Technical Magazines

**Modern Plastics.* 122 East 42nd Street, New York, N. Y. $6.00
**Plastics Industry.* 130 Clarendon St., Boston 16, Mass. $3.00

General Magazines

***Dupont Magazine.* E. I. DuPont de Nemours & Co., Inc., Wilmington, Del. Free
Fortune Magazine. 540 North Michigan Avenue, Chicago, Ill. (May, 1950 issue only)
**Home Craftsman.* 115 North Street, New York 13, N. Y. $2.50
Industrial Arts and Vocational Education. 400 North Broadway, Milwaukee, Wis. (10 issues) $3.00
**Mechanix Illustrated.* 1501 Broadway, New York, N. Y. $2.40
**Popular Homecraft.* 919 North Michigan Avenue, Chicago, Ill. $2.00
**Popular Mechanics.* 200 West Ontario Street, Chicago, Ill. $3.50
**Popular Science.* 353 Fourth Avenue, New York, N. Y. $3.00
**School Shop.* 330 South State Street, Ann Arbor, Mich. Free
***Science and Mechanics.* 154 East Erie Street, Chicago 11, Ill. $1.00

TRADE JOURNALS

***Canadian Plastics.* 341 Church Street, Toronto, Ont., Canada. $12.00
**Materials and Methods.* 330 West 42nd Street, New York, N. Y. $2.00
**Plastics World.* 551 Fifth Avenue, New York, N. Y. $3.00

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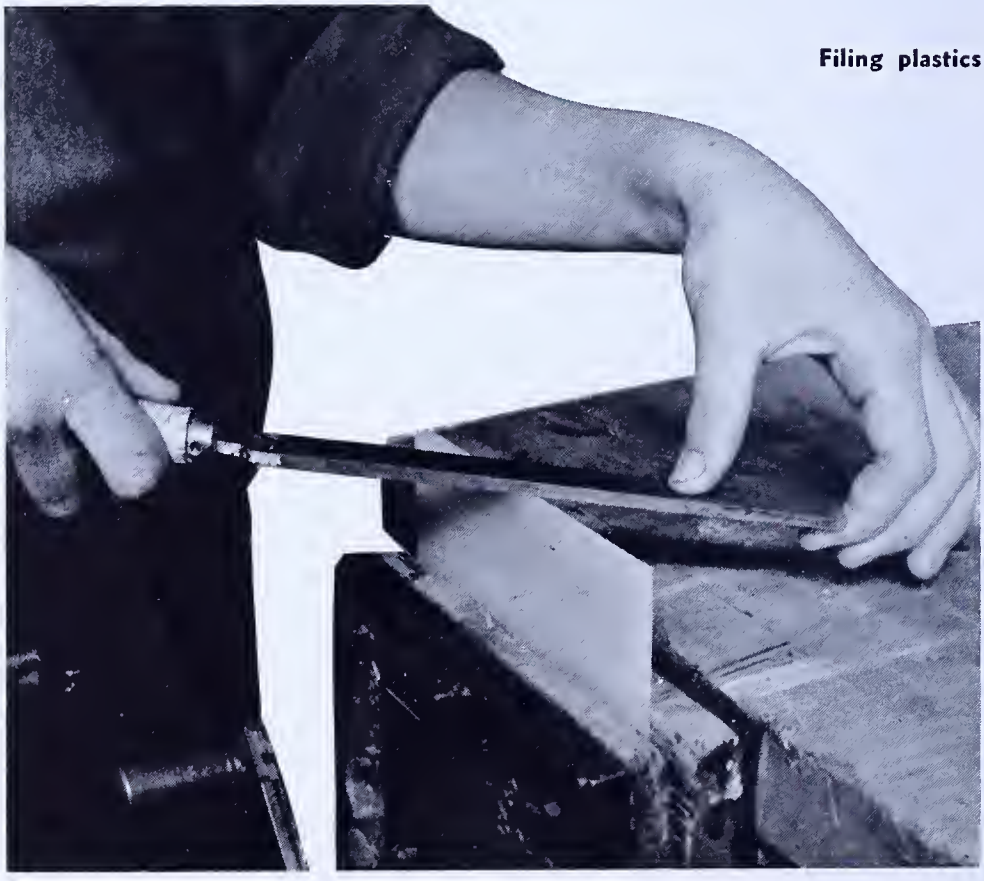
* Published monthly ** Published bimonthly



Filing plastics

FILMS

Careers for Cellulose. This color film tells a story which begins in the cotton fields of the South and continues to the plants of the Hercules Powder Company, where cotton linters are transformed into cellulose derivatives. From these chemical bases, cellulose plastics, lacquers, film, rayon, and other useful articles are produced. Hercules Powder Co., Advertising Department, Wilmington, Del. 16 mm., 3 reels, 3 minutes. Return transportation charged

Figures of Quality. This full-color film shows the actual making of a batch of synthetic resin. Hercules Powder Co., Advertising Department, Wilmington, Del. 16 mm., 14 reels, 10 minutes. Return transportation charged

Formica Story. The story of a laminated plastic: how it is made, and where and how it is used. It shows the methods of manufacture; the close control methods used in production; the impregnation of paper, cotton, asbestos, glass, and wood with thermosetting resins; and the curing of these laminations into homogeneous sheets, tubes, rods, and molded forms. The Formica Co., 4620 Spring Grove Avenue, Cincinnati 32, Ohio. Return transportation charged

Kingdom of Plastics. The basic types of plastic compounds and their uses are described. General Electric Company, Visual Education Section, 1405 Locust Avenue, Philadelphia, Pa. 16 mm., sound, 1 reel, 10 minutes. Transportation charged both ways

Living With Formica. The story of Formica, a laminated plastic, which tells how it is made, and how it is used to make life more comfortable. It traces the development of this product in the fields of architecture, design, and construction. The Formica Company, 4620 Spring Grove Avenue, Cincinnati 32, Ohio. 16 mm., full color, 2½ reels, 27 minutes, sound. Return transportation charged

Magic of Coal. An insight into the many uses of coal, which is not only a primary source of power and light, but also of medicinal products and plastics. Princeton Film Center, Princeton, N. J. 16 mm., sound, 2 reels, running time 18 minutes. Transportation charged both ways

Making a Plastic Fruit Bowl. The elementary steps in making a simple plastic fruit bowl. Produced by the Information Service and Industrial Education Department of Iowa State College, Ames, Iowa. Available through the Industrial Education Department, Iowa State College. 16 mm., sound, color, 15 minutes

Methods of Processing Plastic Materials. Fundamentals of the compression, transfer, extrusion, and injection molding methods; finishing molded parts; fundamentals of laminating; and machining laminated and other plastics products. Government Films Dept., United World Films, Inc., 1445 Park Avenue, New York, N. Y. 16 mm., sound, 21 minutes. Purchase price, $37.32

Oil for Aladdin's Lamp. Research scientists have a place of honor in this picture. In a trip through the laboratory, the audience is given glimpses of the work being done in petroleum research, the creation of chemical miracles from petroleum, including the making of rubber and plastics. Shell Oil Co., Film Library, 50 West 50th Street, New York 20, N. Y. 16 mm., sound, 3 reels, 28 minutes

Origin and Synthesis of Plastic Materials. The origin and synthesis of plastic materials, showing the basic chemicals used in making thermosetting and thermoplastic materials, and illustrating the process of making plastic resins from the raw materials to the final molded part. Shaw Insulator Co., Attention: Sales Manager, 160 Coit Street, Irvington, N. J. 16 mm., sound, 1 reel, 15 minutes. Return transportation charged

Plastics. The growth of the plastics industry, with particular emphasis on new uses developed during World War II. Some scenes show manufacture and fabrication of articles from plastic materials. Young America Films, Inc., 18 East 41st Street, New York 17, N. Y. 16 mm., sound, 16 minutes. Purchase price, $55.00

Scientific Approach to Better Plastics. This film shows the constant research to improve plastic products. Society of the Plastics Industry, Inc., 67 West 44th Street, New York 18, N. Y. 16 mm., sound, 2 reels, 20 minutes. Return transportation charged

Working with Plexiglas. This full-color film shows, in detail, methods and techniques for the fabrication and internal carving of plexiglas. Rohm & Haas, Washington Square, Philadelphia, Pa. 16 mm., sound, color, 40 minutes

FILM SOURCE CATALOGS

Educational Guide to Free Films. Educational Progress Service, Randolph, Wis.

Education Film Guide. The H. W. Wilson Company, 950 University Avenue, New York 52, N. Y.

CHARTS

Enlargement chart and bulletin describing Durez. Durez Plastics and Chemicals, Inc., North Tonawanda, N. Y.

How to Make It With Plexiglas. Rohm & Haas Co., Washington Square, Philadelphia 5, Pa.

Plastics Reference Chart. Behr-Manning Corp., Division on Norton Co., Troy, N. Y.

BOOKLETS

Acrylic Plastics (Plexiglas). Craftsman Supply House, Scottsville, N. Y.

Automotive Catalog. Resistoflex Corporation, Belleville 9, N. J.

Cameos. Craftsman Supply House, Scottsville, N. Y.

Catalin-Cast Resins (Liquid Resins, Molding Compounds). Catalin Corporation of America, 1 Park Avenue, N. Y.

Celanese Plastics. Celanese Corporation of America, 180 Madison Avenue, N. Y.

Celanese Magazine. Celanese Corporation of America, 180 Madison Avenue, N. Y.

Colorful Plastic Surfaces of Formica. Formica Insulation Company, Cincinnati, O.

Compars—New Family of Rubber-Like Materials. Resistoflex Corporation, Belleville 9, N. J.

Corrosion-Resisting Synthane. Synthane Corporation, Oaks, Montgomery County, Pa.

Diamond Vulcanizing Fibre. Continental-Diamond Fibre Company, Newark, Del.

Dilecto—A Laminated Phenolic Plastic. Continental-Diamond Fibre Company, Newark, Del.

Durez from Raw Materials. Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y.

Durez Plastics Primer. Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y.

Electrical Insulating Materials. Continental-Diamond Fibre Co., Newark, Del.

Ethocel (Ethylcellulose). Dow Chemical Co., Midland, Mich.

Fabrication of Catalin—Methods and Equipment. Catalin Corporation of America, 1 Park Avenue, New York, N. Y.

Fellowcraft General Catalog. Fellowcraft, Inc., 130 Clarendon Street, Boston 16, Mass.

Flock, Its Application and Usage. Rayon Processing Company of Rhode Island, Inc., 86 Tremont Street, Central Falls, R. I.

Fulfilling the Promise of Plastics. Dow Chemical Company, Midland, Mich.

Geon Polyvinyl Materials. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio.

Heller F45 File Catalog. Heller Brothers Company, 865 Mt. Prospect Avenue, New York 4, N. Y.

Heller Nucut Files. Heller Brothers Company, 865 Mt. Prospect Avenue, New York 4, N. Y.

Heller Rotary File Catalog. Heller Brothers Company, 865 Mt. Prospect Avenue, New York 4, N. Y.

Heller T44 Tool Catalog. Heller Brothers Company, 865 Mt. Prospect Avenue, New York 4, N. Y.

Hydraulic Plastics Injection Molding Machines, Models 250 and 350. Hydraulic Press Manufacturing Company, Mount Gilead, Ohio.

Laminated Plastics Catalog. Taylor Fibre Company, Norristown, Pa.

Lucite Manual. E. I. DuPont de Nemours and Co., Inc., 626 Schuyler Avenue, Arlington, N. J.

Loalin, Polystyrene Molding Compounds. Catalin Corporation of America, 1 Park Avenue, New York, N. Y.

Lumarith Transparent Film. Celanese Corporation of America, 190 Madison Avenue, New York 16, N. Y.

Machining Data on Phenolic Plastics. Durez Plastic and Chemicals, Inc., North Tonawanda, N. Y.

Non-Metallic Base Materials. Bulletin GF46, C-D. Continental-Diamond Fibre Company, Newark, Delaware.

Phenol Plastics (Catalin). Craftsman Supply House, Scottsville, N. Y.

Plastic Push and Kick Plates of Formica. Formica Insulation Company, Cincinnati, Ohio.

Plastics Bulletins (Nos. 31, 33, 35, 36, and 37). E. I. DuPont de Nemours and Co., Inc., 626 Schuyler Avenue, Arlington, N. J.

Plastics—Three Pressure Processing of Synthetic Resins. No. 4404, Hydraulic Press Manufacturing Company, Mount Gilead, Ohio.

Plastics, The Story of an Industry. Society of Plastics Industry, Inc., 295 Madison Avenue, New York 17, N. Y. (Single copies free.)

Plexiglas—Mechanical Properties. Rohm & Haas Company, Washington Square, Philadelphia 5, Pa.

Plexiglas on Guard (machine safety). Rohm & Haas Company, Washington Square, Philadelphia 5, Pa.

Practical Methods of Machining Bakelite-Laminated. Synthane Corporation, Oaks, Montgomery County, Pa.

Presses for Compression and Transfer Molding of Plastics, No. 4702. Hydraulic Press Manufacturing Company, Mount Gilead, Ohio.

Protective Clothing (general catalog). Resistoflex Corporation, Belleville 9, N. J.

Resistoflex Industrial Catalog. Resistoflex Corporation, Belleville 9, N. J.

Story of Celanese Plastics. Celanese Corporation of America, 180 Madison Avenue, New York 16, N. Y.

Story of Plastic Molding. Chicago Molded Products Corporation, 1020 North Kolmar Street, Chicago 51, Ill. (Single copies free to teachers only.)

Styron (Polystyrene). Dow Chemical Company, Midland, Mich.

Synthane Laminated Plastic Tubing for Radio and Electrical Work. Synthane Corporation, Oaks, Montgomery County, Pa.

Synthane Technical Plastics. Synthane Corporation, Oaks, Montgomery County, Pa.

Technical Plastics for Industry. Synthane Corporation, Oaks, Montgomery County, Pa.

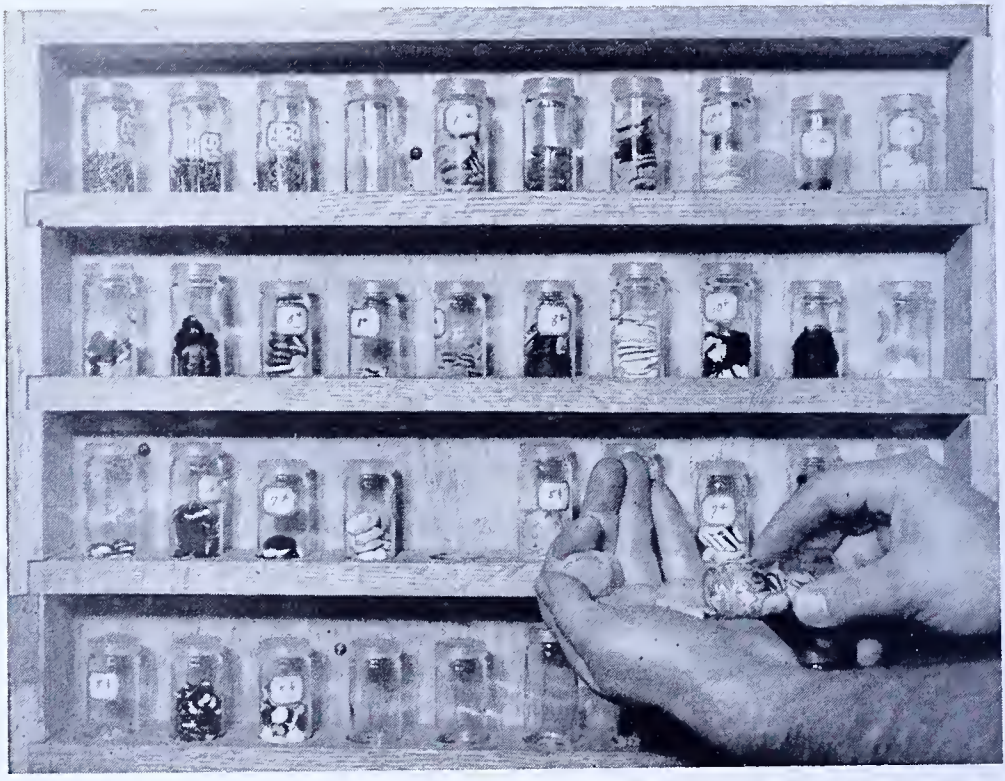
Technical Plastics Sample Book. Synthane Corporation, Oaks, Montgomery County, Pa.

Turbojector for Injection Molding of Rubber, No. 4601. Hydraulic Press Manufacturing Company, Mount Gilead, Ohio.

Unit Prepackaging. Celanese Corporation of America, 180 Madison Avenue, New York 16, N. Y.

Vimlite. Celanese Corporation of America, 180 Madison Avenue, New York 16, N. Y.

What Industrial Formica Is. Formica Insulation Company, Cincinnati, Ohio.



Plastics display and storage

6 Equipment and Supplies

MACHINERY, TOOL, AND SUPPLY LISTS

Heating and bending plastics by using strip heater

THIS SECTION SUGGESTS to the teacher of Industrial Arts how to select equipment and consumable supplies, and how to order them. In addition, lists of equipment and supplies needed are presented for each area of the Plastics unit.

The suggested lists of equipment and supplies are based on an enrollment of five pupils in the Industrial Arts Plastics area of the comprehensive general shop. The lists may be changed to meet local needs.

How to Select Equipment

Several factors are to be considered in determining the quantity and type of equipment to be selected. Briefly they are:

1. The objectives to be attained
2. The activities planned
3. The size of classes

4. Content and scope of course
5. Whether for junior or senior high school or both
6. Type of tool arrangement
7. Funds available

How to Specify and Order Equipment and Supplies

The purchase of suitable equipment for Industrial Arts shopwork requires considerable thought and study so that the equipment purchases will adequately fit the planned program of instruction.

It is essential that complete written specifications be prepared to submit to various firms for bidding. These specifications, based on manufacturers' catalog numbers and descriptions, should ordinarily be written around the specific item which most nearly meets the requirements. To prevent discrimination when writing specifications, it is advisable to write "or equal" following the description of each item, or in "Instructions to Bidders" which generally precedes the listings.

The essential information generally required to write specifications includes:

1. Item number
2. Quantity desired
3. Unit of measure
4. Catalog number
5. Name of item
6. Complete description

The example given below indicates the general procedure to be followed in ordering equipment and supplies:

Item No.	*Quantity*	*Catalog Number and Description*
1	1 only	No. 31-105 12" abrasive disc finishing machine with #50-432 steel stand, tilting table, #864, or equal.
2	2 only	Auto-set miter gauge, #86-720, ¾ H.P., 220 V, 3-phase, 60 cycle, A. C. motor, #1320, 3-phase manual starting switch for 220 V motor, necessary clamp fittings, or equal, #1322 mounting parts, and #49-315-3 wire armored cable, or equal.
3	4 only	No. 308B, ball peen hammers, 8 oz., polished face and peen, black body, or equal.

How to Keep a Shop Inventory

Many different methods of keeping shop inventory are used in Industrial Arts shops. The type and form used depend somewhat on the local school organization. In large school systems, methods of keeping inventory are set up by the administrative office. However, in smaller systems the job of keeping an inventory is the responsibility of the individual shop teacher. A few of the more important advantages in keeping an accurate shop inventory are:

1. It reveals at all times how much stock is on hand
2. It provides accurate information as to what was used during the past year
3. It enables the teacher to determine the amount needed for next year
4. It justifies desired quantities on requisitions to the superintendent and the board of school directors

A suggested form that has been used successfully by many teachers is shown below.

SAMPLE INVENTORY FORM

On Hand		*To Be Ordered*		*Cost*	
Start of Year	*End of Year*	*To Be Ordered*	*Description*	*Each*	*Total*

Tool, Machinery, and Other Equipment Lists

The selection of hand tools, power tools and other equipment is of considerable concern in the development of an area of instruction in the comprehensive general shop. Plastics can be worked with the common metalworking and woodworking tools found in the average shop. Therefore, a unit of instruction can usually be added at the junior high school level for little expense. Additional machinery will be required for advanced work at the senior high school level.

The following list contains all the necessary tools, machinery, and miscellaneous equipment for both a junior and senior high school unit in plastics, including the items found in the woodworking and metalworking area of a comprehensive general shop. It also contains the equipment required for more advanced work at the senior high school level. The only additional equipment required to carry out a successful program in an average junior high school general shop would probably be a buffer, a heating device, several shallow pans, a piece of glass, several acid-type and water-color brushes, and several hypodermic needles.

The list of equipment includes the requirements for the adequate instruction of five pupils in the Plastics area.

All estimated costs are based on 1952 catalog listings, and are, therefore, subject to fluctuation.

SUGGESTED LIST OF TOOLS AND OTHER EQUIPMENT

Quantity	*Item and Specifications*	*Cost**
2	Awls, scratch, 6″ steel blade extending through handle	$1.08
1	Brace, ratchet bit, 8″	6.59
	Brushes	
6	acid-type, 3/8″ wide, 6″ long	1.55
6	water-color, No. 2 small, fine tip	3.54
	Calipers	
1	6″ inside, spring-type, solid nut	2.40
1	6″ outside, spring-type, solid nut	2.40
1 set	Carving tools, wooden handles, length 6 1/4″, forged and heat-treated steel blades, high quality 5/16″ straight chisel, 3/8″ bent gauge, 3/8″ bent chisel, 3/32″ U-tool, 1/4″ skew chisel, 3/32″ veining tool	19.25
	Clamps	
4	C style, 6″	7.20
4	C style, 3″	4.00
4	I-bar style, 2′	17.28
2	Compasses, pencil, 6″, good quality	.50
1	Countersink, brace, 3/4″	.73
1 set	Curves, irregular	7.50
1 set	Dies, National Standard, round die; screw plate, high quality alloy steel, including dies, die stocks, tap and tap wrenches, 4-36 NF, 6-32 NF, 8-32 NF, 1024 NF	25.50
	Dividers	
2	spring-type, 6″, solid nut	4.80
2	spring-type, 8″, solid nut	2.75
	Drills	
1 doz.	carving, taper ground, H.S.S., 1/8″ shank	10.00
1/2 doz.	carving, taper ground, H.S.S., 3/32″ shank	5.00
1	hand, 1/4″ capacity, 3-jaw chuck, solid double pinion gear	5.42
2 each	straight-shank letter, H.S.S., I.Q.R.F.U	7.76
1 set	straight shank, H.S.S., 1/16″ to 1/2″ by 64ths	25.42
1 set	straight shank, H.S.S., No. 1 to 60 wire gauge	19.61
1 doz.	Eye dropper	.10
2	File cards	1.50
	Files	
4	half-round, 2d cut, 8″, double-cut	2.60
4	hand, 2d cut, 8″, double-cut	1.92
4	mill, 2d cut, 8″	1.32
4	mill, smooth-cut, 8″	1.72
1 set	needle, cut No. 0 (set of 12) including round, barrette, half-round, round-edge joint, three-square, equalling, crossing, slitting, knife, marking half round, flat and square	6.23

* Cost of items as of May, 1952.

Quantity	*Item and Specifications*	*Cost*
4	round, bastard-cut, 8″, double-cut	$2.60
4	square, 2d cut, 8″, double-cut	2.00
4	three-square, 2d cut, 8″, double-cut	2.00
4	"Vixenor," 8″ flat, curved-cut, 2d cut	4.00
1	Funnel, enameled, 5″ diameter	.25
2	Gauges, marking, metal, single bar, 6½″, graduated in 16ths	2.00
2 pcs.	Glass, plate, 12″ x 12″, ¼″ thick	.75
2 prs.	Gloves, rubber	3.00
	Hammers	
2	claw, 7 oz.	4.60
2	claw, 13 oz.	4.60
1	Mallet, rawhide, 10 oz.	2.00
2	Needles, hypodermic	4.50
4	Pans, shallow enamel, various sizes	1.35
	Planes	
2	block, 6″	7.50
	Pliers	
1	combination, 6″	.47
1	cutting, diagonal, 6″	2.33
1	needle-nosed, long, 6″	1.97
	Punches	
2	center, ¼″ x 4″ forged alloy steel	.40
2	prick, ⅜″ x 4½″ forged alloy steel	.40
6	Rules, 12″ steel, graduated—in ⅛″, 1/16″, 1/32″ and 1/64″	12.00
	Saws	
1	back, 12″, 14 point	3.80
2	hack, adjustable, 8″, 10″, and 12″; complete reinforced handle, 32 points	2.50
2	Scissors, 8″	2.75
	Screw drivers	
1	2½″ carbon steel blade, wooden handle	.60
1	forged steel blade, 4″, break-proof plastic handle	.92
1	forged steel blade, 6″, break-proof plastic handle	1.21
1	forged steel blade, 8″, break-proof plastic handle	1.63
	Screws, hand	
4	No. 0	9.48
4	No. 2	12.00
3	Scribers, pocket-type, ¼″ diameter, handle, blade 2⅞″	2.10
1 set	Slips, carving tool	2.40
	Squares	
2	combination, 12″ blade, graduated in ⅛″, 1/16″, 1/32″, 1/64″	2.60
1	steel, 24″ x 16″	2.80
2	try, 6″, all-metal	2.24
1	Strip Heater (to be made in the shop)	1.25

Quantity	*Item and Description*	*Cost*
	Stones	
1	oil, 8″ x 2″ x 1″, India, combination	$1.90
1	slip, India gauge	1.75
1	T-bevel, 6″ blade	1.58
2	Tin snips	3.98
4	Tweezers, straight, 6″	1.00
	Vises	
4	bench-type with swivel base, 3″ jaw, smooth	25.00
1	drill press, 3″ capacity	4.50
2	pin, with collet capacity 0″ to 1/16″	
1	Wrench, adjustable, 6″ crescent	.98
	Total	$343.36

MACHINERY

Quantity	*Item and Description*	*Cost**
2	Buffer, 1/2 h.p., 3450 R.P.M., 7″ buffing wheels, adjustable hoods, pedestal-type	$102.00
1	Drill press, 14″, with set of machine spur bits and sanding drums, Jacobs chuck	152.00
1	Flexible shaft machine, 1/2 h.p. universal motor, 12,000 R.P.M., 49″ flexible shaft with detachable ball-bearing handpiece, 1/16″, 3/32″, 1/8″, 1/4″ collets, with foot rheostat	39.25
1	Heating unit, used electric oven with thermostatic control to 400° F. (Other devices, such as an electric hot plate, inverted electric iron, and infra-red lamp are satisfactory)	25.00
1	Jointer, 6″, with steel stand and motor	179.10
	Lathes	
1	metal-turning, 9″ screw-cutting, with all accessories, including collets	387.00
1	wood-turning, complete with turning tools, 3″ and 6″ face plates, Jacobs chuck center	234.85
1	Rotary tool, 25,000 R.P.M., 110 V, 60-cycle, A.C., complete with grinding, drilling, and polishing accessories	27.50
1	Sander, wet and dry flexible belt, floor-type, belt capacity 1/2″ to 3″ wide from 95″ to 120″ long, 3500-4000 surface feet per minute, 1/3 h.p. motor	245.00
1	Sander, combination belt and disc, 10″ disc, 4″ x 52 1/2″ belt	128.50
	Saws	
1	band, 14″ wood and/or metal-cutting with steel stand and motor with 26″ or 28″ gauge saw blades 1/4″, 3/8″, 1/2″ wide, 14 to 15 teeth per inch, wavy set	256.85

* Cost of items as of May, 1952.

Quantity	*Item and Description*	*Cost*
1	circular, 10″ tilting arbor, 10″ hollow-ground blades, 8 to 12 teeth per inch, $\frac{1}{16}$″ thick-filed negative rake, $\frac{1}{8}$″ thick, Carborundum cut-off wheels $\frac{3}{32}$″ thick, 8″ diameter	$360.26
1	jig, 24″, four-speed, with steel stand and motor; machine files, number 3, 4, and 5 jeweler blades 6″ long	154.40
1	Vibro tool, including standard needles for engraving, and abrasive points	9.95
		$2,301.66
	Total for all equipment	$2,645.02

Suggested List of Consumable Supplies

The following list of consumable supplies is by no means complete as to the various kinds, shapes, and sizes of plastics. It does, however, represent a cross-section of the material available and the types and kinds of plastics found satisfactory for Industrial Arts use. The quantity of each item listed is based on the estimated quantities required for adequate instruction of five pupils for one school year.

Any consumable supply list for the plastics area of a comprehensive general shop will, to a great extent, depend on the course of instruction. However, since plastics is an area in which a teacher should encourage the creative instinct of a pupil, it is desirable to have on hand a great variety of shapes, sizes, and kinds of plastics.

The development of this activity area should not be omitted because it is assumed that plastic materials cost too much. The cost of plastic supplies is not so high as might first be thought. Most plastic supply houses have, in addition to first quality stock, second quality stock which has been found very satisfactory for school and hobby use. Second quality stock is listed as such because of very slight off-thicknesses and off-colors—satisfactory for small projects generally constructed at the junior high school level. Furthermore, most plastics projects are small in size, which generally keeps the cost of projects relatively low. In many cases several very worthwhile plastics projects can be completed for the cost of an average woodworking project.

CONSUMABLE SUPPLIES

Quantity	*Item and Description*	*Cost*
	ABRASIVES	
50 sheets	garnet cabinet paper, 1/2 grit	$4.24
50 sheets	garnet cabinet paper, 2/0 grit	3.29
50 sheets	silicon carbide wet finishing paper, 200 grit	4.50
50 sheets	silicon carbide wet finishing paper, 400 grit	4.50
50 sheets	garnet finishing paper, 3/0 wet or dry	9.25
250 sheets	garnet finishing paper, 7/0 wet or dry	9.25
	ACCESSORIES	
3	atomizers	1.20
½ dozen	fountain pen sets, complete with funnels and swivels	
1 dozen	key chains	1.70
3	midget cigarette lighters	1.20
6	perfume bottles	.30
	BUFFING AND POLISHING MATERIALS	
2 pounds	buffing tallow	1.20
3	buffing wheels, 7″ diam. x 1″ face, sewed muslin	3.25
3	buffing wheels, 8″ diam. x 1″ face, loose flannel	3.25
1 quart	cleaner and wax, anti-static, for acrylic plastics	1.25
2 pounds	diamond white 4x	2.20
1 quart	rubbing compound, automotive type	1.18
2 pounds	triple, No. 40	1.30
	CASTING MATERIALS	
2 pounds	castolite or plasticast	5.00
1 pound	plaster of Paris	.15
	CAST RESINOIDS*	
5	bars—select a variety of shapes and colors	5.00
3	ring tubes—select assorted sizes and colors	1.20
5	sheets, 12″ x 24″—select a variety of mottled colors and thicknesses	7.50
	CEMENTS	
1 quart	clear laminating	2.00
2 oz. each	colored laminating—select a variety of colors	7.00
½ doz. tubes	Duco Household	1.20
1 quart	ethyline dichloride	2.00
	DYES	
1 pint	acetone	.60
8 oz. each	dip, variety of colors	10.00
2 oz. each	internal carving dye, powdered form, variety of colors	8.00

* Marketed under the trade names of Amberol, Bakelite, Catalin, and Marblette.

Quantity	*Item and Description*	*Cost*
	JEWELRY FINDINGS	
1 doz.	bar pins, sterling, small size	$2.00
1 doz.	bow pins, sterling, large size	2.50
½ doz.	buckle catches	.42
4 doz.	cameos, plastic, assorted shapes, colors, sizes	3.00
½ doz.	dress clips	.30
2 doz.	ear wires—metal screw type, acetate insert	.90
2 doz.	ear wires—metal screw type, dangling style	.90
2 doz.	ear wires—plastic slip-on type	.24
4 doz.	jump rings	.48
2 doz.	necklace chains—18″ sterling silver	9.60
2 doz.	pin backs—¾″ plastic	1.20
2 doz.	pin backs—1″ plastic	1.20
1 doz.	pin backs—1″ metal prong	.40
4 doz.	screw eyes	1.20
1 doz.	tie clips	1.60
	PLEXIGLAS OR LUCITE CLEAR TRANSPARENT SHEETS, 12″ x 24″, SECOND GRADE, MASKED BOTH SIDES	
1 piece	1/16″ thick	2.20
1 piece	⅛″ thick	2.86
1 piece	3/16″ thick	3.50
1 piece	¼″ thick	4.14
1 piece	5/16″ thick	4.66
1 piece	⅜″ thick	6.70
1 piece	½″ thick	8.88
1 piece	¾″ thick	12.50
1 piece	1″ thick	18.00
1 piece	2″ thick	29.68
	PLEXIGLAS OR LUCITE COLORED SHEETS, 12″ x 24″, SECOND GRADE, MASKED BOTH SIDES	
1 pc. each	1/16″ thickness – transparent red, blue, green, white, yellow, each $2.00	10.00
1 pc. each	1/16″ thickness—opaque black and opaque white, each $2.00	4.00
1 pc. each	⅛″ thickness – transparent red, blue, green, white, yellow, each, $2.20	11.00
1 pc. each	⅛″ thickness—opaque black and opaque white, each $2.20	4.40
1 pc. each	¼″ thickness – transparent red, blue, green, white, yellow, each, $4.14	20.70
1 pc. each	¼″ thickness—opaque black and opaque white, each $4.14	8.28

Quantity	*Item and Description*	*Cost*
	RODS, PLEXIGLAS OR LUCITE, 48″ LENGTHS	
1 piece	1/8″ diam.	$.32
1 piece	1/4″ diam.	.60
1 piece	3/8″ diam.	1.40
1 piece	1/2″ diam.	1.80
1 piece	5/8″ diam.	2.60
1 piece	3/4″ diam.	3.60
1 piece	1″ diam.	6.00
1 piece	1 1/4″ diam.	9.00
	TUBING, LUCITE, 36″ LENGTHS, CLEAR TRANSPARENT	
1 piece	1/4″ O.D.	.28
1 piece	3/8″ O.D.	.48
1 piece	1/2″ O.D.	.60
1 piece	3/4″ O.D.	1.60
1 piece	1″ O.D.	2.00
1 piece	1 1/4″ O.D.	2.60
1 piece	1 1/2″ O.D.	3.00
1 piece	3″ O.D.	10.00
1 piece	4″ O.D.	12.50
	SCREWS	
1 box	drive No. 2/0 x 1/8″ R.H.	.30
1 box	drive No. 2/0 x 3/16″ R.H.	.30
1 box	drive No. 2/0 x 1/4″ R.H.	.36
1 box	machine 6–32 x 3/8″ F.H.	.39
1 box	machine 6–32 x 3/4″ F.H.	.46
1 box	machine 8–32 x 1/2″ R.H.	.52
1 box	machine 6–32 x 3/4″ R.H.	.46
1 box	machine 8–32 x 1/2″ F.H.	.52
1 box	machine 8–32 x 3/4″ R.H.	.57
1 box	machine 8–32 x 3/4″ F.H.	.57
1 box	machine 8–32 x 1″ F.H.	.65
1 box	machine 8–32 x 1″ R.H.	.65
1 box	plastic 6–32 x 1/2″ F.H.	1.50
1 box	self-tapping No. 2 x 3/8″ O.H.	.32
1 box	self-tapping No. 3 x 5/8″ F.H.	.36
	Total	$346.46

Some Sources of Plastics Supplies[1]

Almac Plastics, Inc.
320 Fifth Avenue
New York, N. Y.

American Handicrafts Co., Inc.
45-49 South Harrison Street
East Orange, N. J.

Broadhead-Garrett Co.
Cleveland 5, Ohio

Cadillac Plastic Co.
651 West Baldwin
Detroit 2, Michigan

Commercial Plastics & Supply Corp.
630 Broadway
New York 12, N. Y.

D. W. Cape—Plastics
7401 Marillar Drive
St. Louis 21, Mo.

Craft Service
337 University Avenue
Rochester 7, N. Y.

Craftsman Supply House
35 Browns Avenue
Scottsville, N. Y.

E. I. DuPont de Nemours Co., Inc.
626 Schuyler Avenue
Arlington, N. J.

Gem-O-Lite
5350 Riverton Avenue
North Hollywood, California

General Electric Company
c/o Chemical Department
1 Plastics Avenue
Pittsfield, Mass.

Hobbycast Plastics, Inc.
4637 N. Ketzie, Dept. C-10
Chicago 25, Illinois

Plasticast Company
P. O. Box 6737
Chicago 25, Illinois

Plastics Center
2015 Market Street
Philadelphia, Pa.

Plastic Mart
340 North 9th Street
Allentown, Pa.

Plastic Parts and Sales
1157 S. Kings Highway
St. Louis 10, Mo.

Plastic Products Co.
371 South Main Street
Salt Lake City 11, Utah

Plastic Supply Co.
2901 North Grand Blvd.
St. Louis 7, Mo.

Plastic Arts
79 North Main Street
Wilkes-Barre, Pa.

Project Publishers
31 South Desplaines Street
Chicago 6, Illinois

Rohm & Haas Company
The Resinous Products Div.
Washington Square
Philadelphia, Pa.

Westinghouse Electric Corporation
300 Fourth Avenue
P. O. Box 1017
Pittsburgh, Pa.

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[1] The Industrial Arts teacher should seek new sources of supply. No list printed here can include all sources.

Storage and Control of Tools

The storage and arrangement of tools depend largely on the physical layout of the shop, type of activities, size of class, money available, and the ease with which the tools can be checked at the end of the shop period. The use of the open tool panel is recommended over other methods because it permits simplicity of administration, economy of time in obtaining and returning tools, and improves the appearance of the shop. The tool panels are fastened to the wall and contain tools normally used in each particular work area. Each panel is painted with a light-colored background with the silhouette of each tool painted in a dark color. In situations where it is inadvisable to use a tool panel, a toolroom should be considered.

Some of the different methods of storage used are:

1. Toolroom
2. Open tool panels (placed according to activities)
3. Tool cupboards
4. Bench racks
5. Bench drawers
6. Individual tool kits or boxes

Storage of Supplies and Projects

Consideration of the storage space for consumable supplies is very important in planning facilities for the Industrial Arts program. If possible, the storage room should be large enough to take care of commercial stock sizes.

A separate room or area within the shop for the storage of unfinished projects should be provided adjacent to the main shop rooms. This room should be equipped with bins and/or shelves, approximately 24″ x 24″ x 30″ for storage of plastics projects. Provision should be made for separate bins or shelves for each class, and for the storage of individual projects as they are being assembled.

A well-organized plan for the storage of supplies and projects pays dividends in helping to keep the shop in good order. To prevent warping and twisting of plastic sheets, they should be stored flat or in properly designed vertical bins.

7 Suggested Shop Layout

FOR FIVE PUPILS

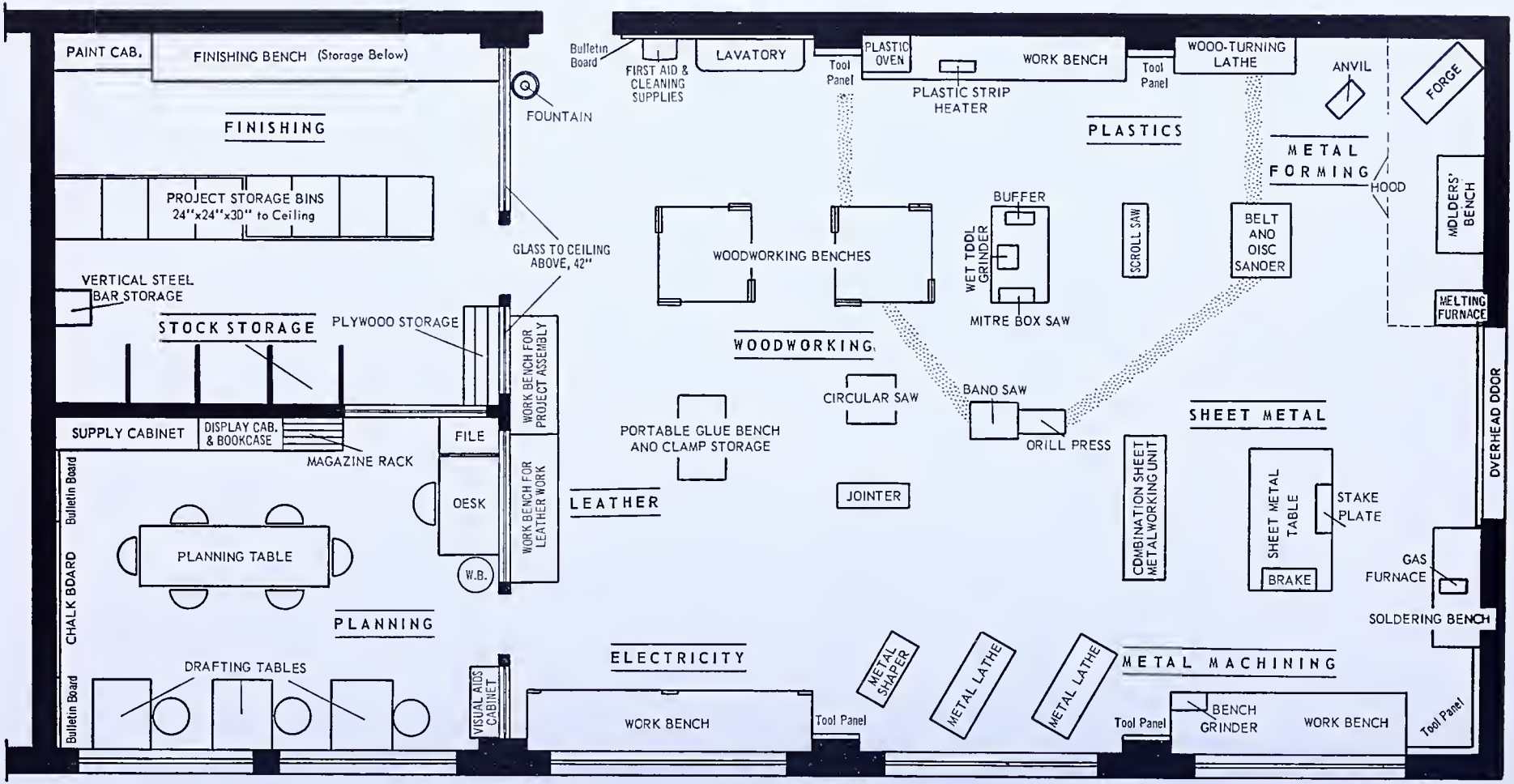
Affixing chain to a plastics project

THE PLASTICS AREA of a comprehensive general shop should be located close to the woodworking and cold metalworking areas, because plastics are worked with woodworking and metalworking tools and machines.

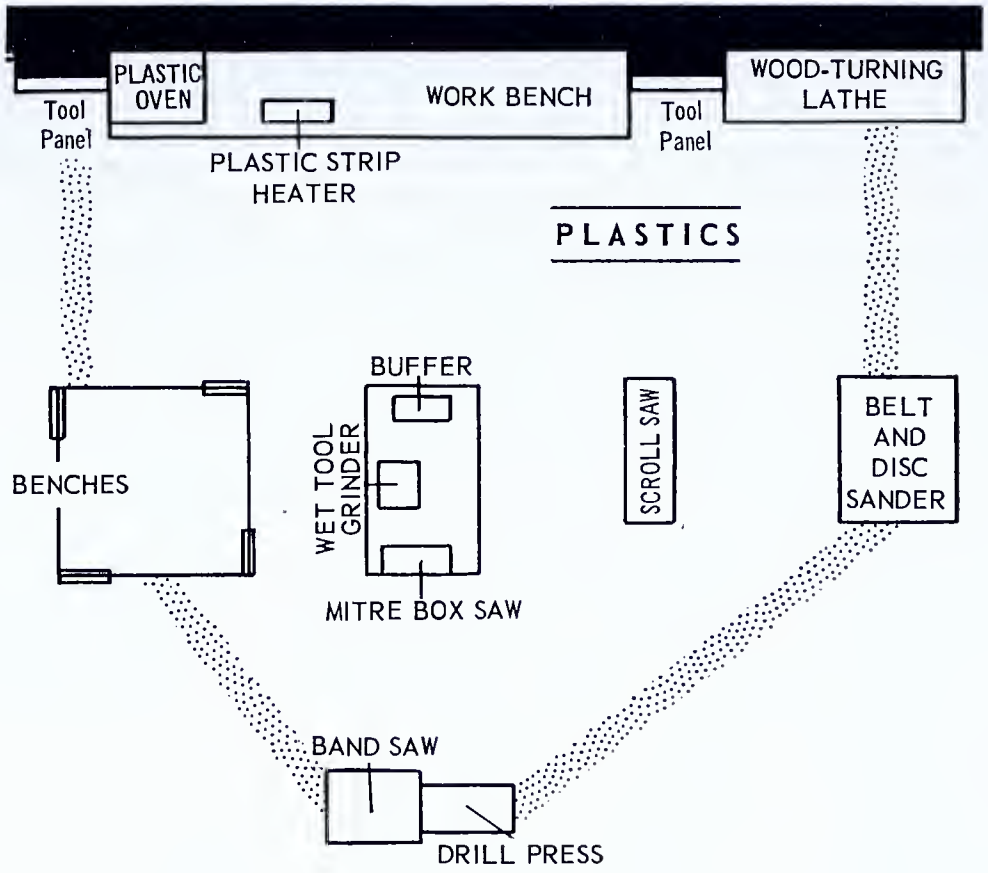
Pictured on pages 52 and 53 is a plastics area (see outlined area), an integral part of a comprehensive general shop, which also includes areas in planning, woodworking, leatherworking, electricity, metal machining, metal forming and sheet metal.

A cabinet for the storage of tools, jigs, and fixtures should be provided in the plastics area under a work bench designed to hold various heating devices for plastics. A work bench 28 inches deep and eight to twelve feet long, totally enclosed below for storage, in addition to other benches in the area, is adequate for instruction. One or two buffers may be mounted on a bench, but experience has shown that pedestal buffers located adjacent to the plastics workbench are preferable.

The plan on page 52 may not fit into the scheme of instruction in all general shops. It is included here only as a suggestion of what must be considered in the making of any shop plan.



A Comprehensive General Shop with a Plastics Area

Plan by Lyle Weissenfluh

Page 52 illustrates the entire Comprehensive General Shop. On this page an enlargement of the Plastics Area is shown.